Popular Astronomy.

Vol. XXI, No. 7. AUGUST-SEPTEMBER, 1913. Whole No. 207

LABORATORY TESTS OF PHOTOGRAPHIC PLATES AND FILTERS FOR ASTRONOMICAL WORK.

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The extensive application of photography to the various lines of astronomical research renders it highly important that the astronomer familiarize himself with the characteristics of the photographic plates upon which he depends for the permanent records of his observations. He must study the photographic processes and make practical tests of plates, so that he may select those best adapted to his work. One essential quality of a photographic plate for astronomical purposes is speed. The photographer in his studio, where exposures are only a few seconds at most, need not be greatly concerned about the speed of his plates. But the astronomer, who makes exposures ranging from a few minutes to several hours and in some cases several nights, must secure fast plates and should have some means of testing the relative speeds of the various plates and emulsions.

Likewise a knowledge of the sensitiveness of plates to the different colors of the spectrum is of great importance. In the photographic studio the background, the illumination and the other conditions of the exposure are arranged to suit the camera and the plate. On the other hand the astronomer is often forced to select plates adapted to special purposes, as when he uses a visually-corrected lens for photographing by placing between the lens and the plate a color-screen or filter which absorbs all the rays except those properly focussed. In this case a plate sensitive to the visual rays, the yellow-green, is required. The differences between so-called panchromatic, orthochromatic, isochromatic and other color-sensitive plates are so marked that only by testing can the astronomer tell which plate best meets his requirements. He should also ascertain the powers of absorption and transmission possessed by his filters in order that he may be assured that they are really fitted for the purpose for which they are intended. A brief description of the instruments and methods employed in making these tests at this observatory may be of interest and value.

Speed Tests.

For determining the comparative speeds of plates a Scheiner rotating sector machine, Plate XXII, *a*, has been found very satisfactory. Opal glass exposed to the north sky is used as a source of light. The light is admitted to the instrument through a comparatively narrow slit placed about 250 mm in front of the plate and after passing through the sector *B* in the rotating wheel *A* falls upon the plates in the holder *C*. As furnished by the maker the sector was in the form of a smooth curve, so that the changes in density on the developed plates were gradual. Subsequently however there was glued to the wheel a disk of black paper cut in sectors as shown in the illustration. Whatever the speed of the sector-wheel, provided it be uniform, the amounts of light acting upon the different portions of the plate are proportional to the angles of the sectors. The ratio of the adjacent angles is as $1:\sqrt{2}$ so that a difference of two steps corresponds to a doubling of exposure time. There are thirteen of these steps whose relative light-values are represented by the following angles:

Step	Angle	Step	Angle
	°		°
1	1.0	8	11.3
2	1.4	9	16.0
3	2.0	10	22.6
4	2.8	11	32.0
5	4.0	12	45.1
6	5.6	13	64.0
7	8.0		

Two test plates, each 23 by 93 mm, coated with the emulsions to be compared, are placed side by side in the holder and exposed simultaneously behind the rotating sector. The corresponding steps of the two plates therefore have precisely the same exposure. If the relative speeds of the plates with respect to light of a given color is desired, a

Figure 1. Scheiner Test Plates.
I. Cramer Inst. Iso. Emulsion 7546. II. Cramer. Inst. Iso. Emulsion 7109.

filter transmitting only the required rays is placed between the slit and the sector wheel in an opening provided for the purpose. The exposure time varies from ten or twenty seconds to as many minutes, depending on the brightness of the sky, the kind of plate and the filter used. The sector is rotated by means of the wheel *D* or by an electric motor in the longer exposures.

After exposure the test plates are developed in the same tray under conditions similar to those in ordinary practice. Figure 1 shows a test of two emulsions of Cramer Instantaneous Isochromatic plates made with a "visual-luminosity"* filter. A simple inspection of the test plates suffices to show their relative speeds, as by the juxtaposition of the steps of equal opacity the relation between the two is evident. If the thirteenth step of one corresponds with the eleventh step of the other in opacity then the latter plate is said to be about twice as fast as the

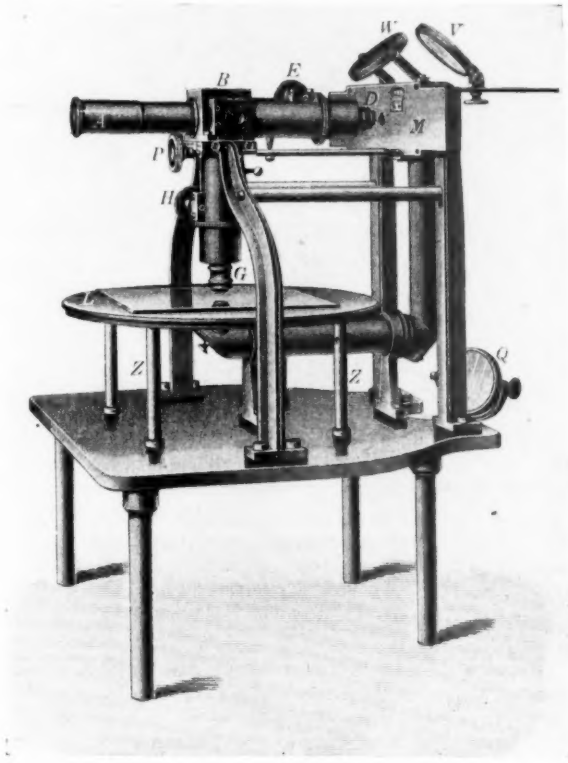


FIGURE 2. HARTMANN "MICROPHOTOMETER."

former, since under the same conditions it shows an equal opacity in half the exposure time. In the illustration the gradations of the originals are not reproduced with sufficient accuracy to permit of comparison in this manner.

* Similar to that described on page 8.

To represent the results graphically, the opacities of the various steps are measured on a Hartmann "Microphotometer,"*, Figure 2, and the curves plotted using the scale-readings, corresponding to opacities, as

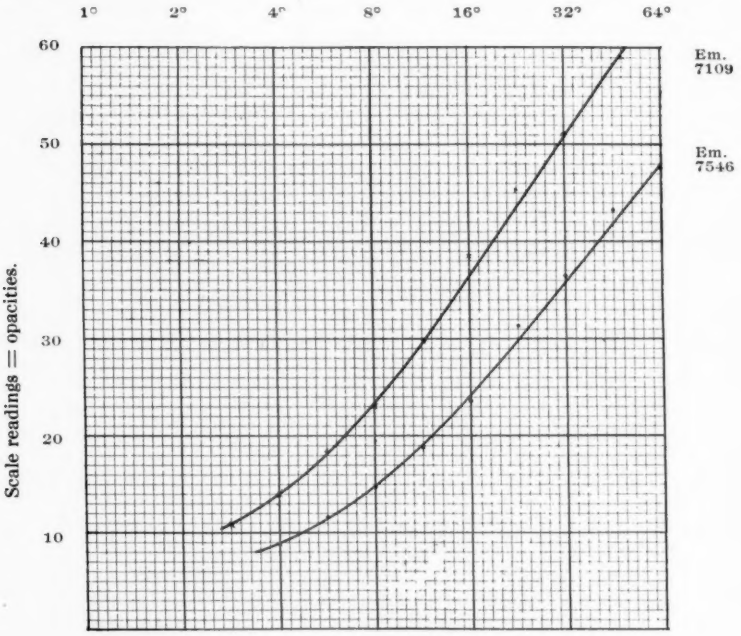


FIGURE 3. OPACITY CURVES SHOWING RELATIVE SPEEDS OF CRAMER INST. ISO. PLATES. EMULSIONS 7546 and 7109.

* The "Microphotometer" is an instrument designed by Hartmann of Potsdam for the direct measurement of opacities on photographic plates. It is described in detail by the inventor in the *Astrophysical Journal* **10**, 321, 1899. For the benefit of those who are unable to refer to that article a cut of the instrument, Figure 2, has been inserted. From some source of illumination, natural or artificial, at *Q* light is reflected through the plate to be measured at *G* and through a movable "photographic wedge" at *D*. Both images are made to appear simultaneously in the eyepiece at *A* by means of a Lummer-Brodhun prism B. The wedge may be moved along by means of the pinion *P* until the opacities of the two plates appear equal, the position of the wedge being read from a millimeter scale and vernier attached to it. Investigations of the wedge used here show a fairly uniform increase in absorption, so that the opacities of measured plates may be expressed directly in scale-readings. If necessary the scale-readings may be translated into stellar magnitudes or Hurter and Driffield density-units, as the wedge has been calibrated for both of these scales.

ordinates and the sector-angles, representing exposure times, as abscissae. Figure 3 gives the curves obtained in this way from the plates shown in Figure 1. The range of opacities extends from the least measureable, i.e. the film fog, to an opacity greater than is ordinarily used when printing from negatives. The general relation of the two curves is evident and may be translated into numerical terms according to the rule, that for any given ordinate the speeds of the plates are inversely proportional to the abscissae. Thus for these curves at an opacity of 30 the speeds are expressed by the equation

$$\frac{\text{Emulsion 7546}}{\text{Emulsion 7109}} = \frac{11^\circ}{22^\circ}.$$

Emulsion 7546 is therefore only half as fast as Emulsion 7109 for this opacity. It is seldom strictly correct to say that one plate is so many times as fast as another unless the opacity is specified, for such a statement assumes that the horizontal distance between the curves is the same for all opacities, while as a matter of fact it varies considerably and in some cases the curves even cross each other. So the choice of the fastest plate for a given purpose may be influenced by the opacities required in the developed images.

In this work the same emulsion is used as a standard for successive tests, so that other emulsions may be compared with one another by their respective relations to that standard. The following tables give the results of some of the recent tests of both ordinary and color-sensitive plates with the relative speed-values found with respect to the standards used. The values were obtained from the general relations of the curves and not with reference to any particular opacity. Table I shows the tests of ordinary plates without a filter. The standards used were Seed 27, Emulsion 13185 and Seed 30, Emulsions 13256 and 13530. As these plates have practically the same speed, the results of comparisons with them are incorporated into one table. The first column gives the number and the second the date of the test; the third column the kind of plate; the fourth, the emulsion number; the fifth, the relative speed of the plate considering the standard as unity; and the sixth column, the standard used, the standards being numbered in the order mentioned above. The year is omitted from the date to save repetition. As the tests were made between July 1, 1912 and April 1, 1913 there can be no uncertainty as to the year.

TABLE I.

Standards:—
1. Seed 27 Emulsion 13185.
2. Seed 30 Emulsion 13256.
3. Seed 30 Emulsion 13530.

Number	Date	Kind of plate	Emulsion	Speed	Standard
50	July 12	Seed 30	13070	0.7	1
51	July 22	" "	13061	0.5	1
54	July 30	" "	13308	1.0	1
55	July 30	" "	13344	1.4	1
76	Dec. 6	" "	13256	1.0	1
82	Dec. 7	" "	13436	1.0	2
83	Dec. 7	" "	13490	1.4	2
86	Dec. 7	" "	13530	1.0	1
92	Jan. 27	" "	13638	1.0	2
84	Dec. 7	" 27	13417	0.9	1
52	July 22	Ilford Monarch	—	1.4	1
77	Dec. 6	" "	5412	0.7	2
78	Dec. 6	" "	5414	1.0	2
79	Dec. 6	" "	5415	0.7	2
80	Dec. 6	" "	5416	1.0	2
81	Dec. 6	" "	5419	0.8	2
56	Aug. 2	Lumiere Sigma	7614	1.0	1
57	Aug. 2	" "	2256	1.0	1
105	Feb. 28	" "	2123	1.4	2
58	Aug. 13	Hammer	6421	1.0	1
67	Oct. 9	Wellington Press Xtra Speedy	—	0.7	1
99	Feb. 25	Cramer Crown	20723	0.7	2
100	Feb. 25	" "	20835	0.7	2
59	Aug. 13	Central Comet	5443	0.5	1
60	Aug. 13	" Special	5445	0.6	1
90	Jan. 20	" "	5564	1.0	2
98	Feb. 18	" " X	5573	1.0	2
104	Feb. 28	Hauff Ultra-rapid	5005	1.5	2
106	Mar. 3	As de Trefle*	2211	1.0	3
107	Mar. 6	Mawson Gladiator	15400	1.4	3
108	Mar. 6	" Felixi	15432	1.2	3
109	Mar. 6	" Wizard	15402	1.2	3

Table 2 gives the results of tests of color-sensitive plates with a "visual-luminosity" filter. The standard is a Cramer Instantaneous Isochromatic emulsion Number 7109. The columns are the same as Table 1 with the omission of the last.

TABLE II.

Standard:—Cramer Inst. Iso. Emulsion 7109.

Number	Date	Kind of Plate	Emulsion	Speed
65	Sept. 30	Standard Polychrome	8432	0.25
69	Oct. 16	Seed L Ortho	13304	0.4
64	Sept. 30	Cramer Inst. Iso.	7428	0.5
66	Oct. 4	"	7478	0.7
70	Oct. 17	"	7482	0.7
71	Oct. 23	"	7487	0.8
72	Nov. 1	"	7499	0.5
74	Dec. 6	"	7515	0.5
75	Dec. 6	"	7524	1.0
87	Dec. 19	"	7538	0.5
88	Jan. 3	"	7546	0.4
89	Jan. 20	"	7545	0.6
91	Jan. 20	"	7552	0.7
93	Feb. 1	"	7558	0.8
94	Feb. 6	"	7582	1.6
101	Feb. 26	"	7595	0.7
111	Mar. 10	"	7613	0.5
113	Mar. 17	"	7615	1.2
102	Feb. 26	Cramer Medium Iso.	7179	1.2
103	Feb. 26	Cramer Slow Iso.	7177	0.6

* Made by Grieshaber Freres and Co., Saint-Maur, France.

Spectrograph Tests.

For determining the sensitiveness of the plates to different portions of the spectrum, a duplicate was made in our instrument shop of a spectrograph designed by Mr. R. James Wallace. The instrument is shown in Plate XXII, *b*. Diffraction spectra have been found to be better than prismatic spectra for sensitometric purposes, owing to the normal dispersion and the smaller amount of absorption in the ultra-violet. So to obtain the spectrum a replica-grating having 15150 lines to the inch is employed, as suggested by Mr. Wallace for a standard dispersion piece for such work.* The instrument is directed toward the north sky in order that diffused daylight may be used as the source of light. The width of the horizontal slit at *A* is varied from 0.2 to 3.2 mm as needed. The collimator lens has a focus of about 250 mm, the collimator tube *B* being inclined to the grating at *C* at an angle of 13° so that the spectrum of the first order may be used. The camera lens has a focus of 280 mm, giving to the spectrum on the plate at *D* a scale of about 61 Ångström units per millimeter. An adjustable gelatine scale on which the wave-lengths are marked is placed immediately in front of the plate, so that at each exposure the scale is automatically registered on the plate. This scale is adjusted by narrowing the slit till the absorption lines of the spectrum are well defined and then comparing the position of the scale with lines of known wave-lengths, such as the H (3968) and K (3934) lines of calcium, the solar G (4308) and the hydrogen F (4861). The plate holder *D* may be moved along so that several exposures may be made on a 3¼ by 4¼ inch plate.

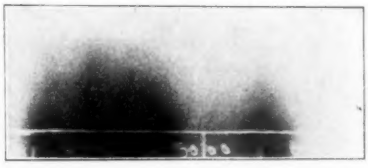


Figure 4. Spectral Intensity-Curve of Cramer Inst. Iso. Plate.

A very ingenious device used with the spectrograph is a revolving sector-wheel *E*, similar to that of the Scheiner sensitometer but having a smooth curve on the wheel. This sector allows such a gradation of light to pass through the various portions of the slit that the curve of sensitiveness of the plate is represented by the shape and opacity of the spectral image. The slit *A* is broadened and moved out of focus so that the absorption lines are spread out, thus rendering the curve smoother. Figure 4 shows the curve of daylight spectrum on a Cramer Instan-

* The Astrophysical Journal **25**, 116, 1909.

taneous Isochromatic plate. It will be seen that the maximum sensitiveness of the plate is in the region of the wave-lengths 3500-4800 with a secondary maximum extending from 5300-5800. If a line is drawn through the points of equal opacity on the plate it will represent in a general way the curve of sensitiveness for that plate. A graphic representation of this curve can also be obtained by measuring on the microphotometer the opacities of the spectrum at different wave-lengths

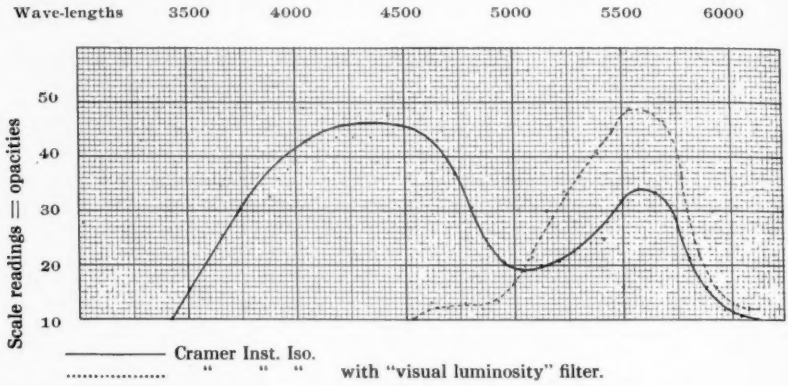


FIGURE 5. SPECIAL INTENSITY-CURVE OF CRAMER INST. ISO. PLATE WITH AND WITHOUT "VISUAL LUMINOSITY" FILTER.

along a line perpendicular to the slit-image. The curve is then drawn using the scale-readings as ordinates and the wave-lengths as abscissae. Figure 5 gives the curve of sensitiveness for the plate shown in Figure 4. The general correspondence between these two is evident. Either one will give the astronomer the information he desires regarding the sensitiveness of his plate to light of different wave-lengths.

THE TESTING OF FILTERS.

To determine what powers of absorption a color-screen or filter possesses, two exposures are made with the spectrograph on a color-sensitive plate, one with and one without the filter placed between the light source and the plate. A comparison of the resulting spectral images shows which portions of the spectrum are transmitted and which cut off by the absorbing medium. Figure 5 will serve to illustrate this. On the same axes with the curve of sensitiveness for the Cramer Isochromatic plate is given the curve for the same plate exposed behind the color-screen which is employed with the visually-corrected lens of the forty-inch refractor when it is used for photographic work. It will be seen that nearly all the rays whose wave-lengths are shorter

than 5000 are absorbed, thus utilizing only the secondary maximum of the plate. It is evident that an ordinary photographic plate which is sensitive to the rays of wave lengths 3600-5000 would be of little use when this filter is employed. Since a visually-corrected lens brings to a focus in the same plane nearly all the rays of wave-lengths 5000-6000, the adaptation of this filter to photographic work with such a lens is manifest.

These speed tests have proven of practical value in the selection of fast plates for different purposes and particularly in securing fast emulsions of Cramer Instantaneous Isochromatic plates for use with the large refractor. The spectrograph tests have given valuable information regarding the sensitiveness of plates and have enabled us to select or discard filters according to their adaption to the use for which they were intended.

Acknowledgements are due to Professor J. A. Parkhurst for helpful suggestions and kindly criticism in the preparation of this article.

Yerkes Observatory,
Williams Bay, Wisconsin.
April 1913.

THE ANSWER OF THE UNIVERSE.

GEORGE HOWARD GIBSON.

William Bayard Hale in the January World's Work closes a highly imaginative article, entitled "Exploring Other Worlds," with this conception of everything and always:

> The incessant expulsion of dust from stars to form nebulae, with the condensation of nebulae into stars and the stellar system, is the order of the universe. It is by means of this infinitely beautiful compensation that the world-process can continue in an eternal cycle, for which there is neither beginning nor end.

So easily, in his mind, Mr. Hale sweeps aside the immeasurably larger idea of eternal progress, the unfolding of the Infinite, and substitutes a little round, and its endless repetition. Why, even man would tire of the monotony of it.

What does the Hale cosmic fancy rest on, or spring from?

A puffball and an hourglass. The experiment of Nichol and Hall, showing that rays of focussed light directed against falling particles of puffball and emery overcome the downward tendency of the former.

In case this was an example of simple repulsion by light, working against the power of attraction, the experiment would show—what?

That nearer the sun, where the light approaches in intensity the concentrated rays used in the experiment, the lightest matter would be held in suspension by the sun, forming a more extended atmosphere than has been supposed--an atmosphere of exceeding tenuity.

Outside the utmost rim or most tenuous part of the sun's atmosphere, in the interstellar spaces, matter, universally attracted, falls. And with it the cycle reasoning falls, or fails.

The tremendous chemical furnace of the sun keeps throwing upward, into an atmosphere millions of miles deep, great volumes of superheated gases; but as the product rises it cools, and falls back again, to form new chemical combinations and produce fresh supplies of heat and light. The evidence supplied by eclipses, across a period of thousands of years, shows no measurable diminution of the sun's volume, no dispersion of its substance.

Heat and electricity resist and play about universal attraction and prolong the process of condensation in celestial bodies. But these forces can check only for a time the integrating tendency of matter; they pass away from the bodies which gave them birth.

Light likewise fails, and leaves its body behind. Regardless of his radiant energy theory of a cosmic cycle, Mr. Hale considers it probable "that there are a hundred times more extinct stars than luminous ones." A hundred to one in disproof of dispersion by radiant energy. And doubtless the other one per cent have their light period, and will become dark with rest.

It is scientifically demonstrable that the stars have grown; that their period of chemical change and radiant energy passes; that integration is not balanced by disintegration. The cooled, non-radiant suns and planets are an absolutely impossible factor for the cosmic-cycle theory.

The course of nature in the large is ever forward. Progress is marked in the unfoldings of all the past, and must continue forever.

There is a law of progress, of sequence, a course of nature traceable with scientific certainty. Traceable scientifically to what went before and will follow after. O how man wants to know what is, what was, and what shall be!

What is! It is what was. To know anything, we must know everything. The whole past reveals or explains the present. Following the certain connections of the natural order we shall discover cosmic truth. We shall read from its great unrollment the answer of the universe to man's questions.

Is the power of the universe in its wholeness necessary, or free; material, or mental?

The beginning of knowledge must be in the individual consciousness, and be added to by observation and comparison. I move at pleasure

my arm, my hand and whatever it contains. I exercise power, and I possess the same power in quiescence when I choose to rest. I choose whether to do this or that. I strike a man maliciously, and all men condemn such action. Every normal mind recognizes its freedom and the freedom of all other minds. Free action by man and invariable action in matter have to be admitted.

Man has dominion. We alter the courses of material events by supermaterial initiative, by the addition of will power. The world that environs us appears to be a realm of unvarying forces whose action is constant, measurable, and exactly predictable. Astronomers who weigh worlds and calculate their orbits and eclipses, and chemists who measure molecules and by syntheses and analyses make and resolve substances, have every evidence that the action in things is constant. Countless observed sequences and exact scientific experiments prove that the so-called material forces of the universe are unvarying. As exact scientists and as ordinary manipulators of the natural forces we make all plans with reliance upon the stability of nature, and are never put to confusion.

One of the forces found in matter, acting in all matter under all conditions, is called the attraction of gravitation—"the force by which all bodies or particles of matter in the universe tend toward each other." This force balances the worlds in their orbits, and were it not for the process of change discovered in the worlds and suns themselves the conclusion would be forced upon us that the present balanced system of relations and motions of the heavenly bodies must reach forward and backward to eternity. But astronomers have discovered that some suns are in the white heat of maturity, some are in the red heat of age, and some have grown dark and cold. The planets, being smaller bodies, have naturally cooled more quickly and are in the dark stage of evolution. In our planet and its satellite we have exceedingly full, complete evidence of cooling worlds, which in their natural climax of heat and in the previous heat-storing process, common everywhere, flash light at last upon the whole problem of the universe.

The figure of the earth, flattened at the poles, indicates that it was once in a fluid state; and that beneath a cooling crust the molten condition has long remained is evidenced by the gigantic sinkings and upheavals, by the great breakings and mountain-range crumplings of its strata, by the elevation of continents which furnish proof of having once been at the bottom of the sea, by continent-wide earthquakes still felt, by present volcanic outflows and the vastly larger areas of ejected lava belonging to ages past. The geologists and chemists have discovered, also, the igneous origin of the primary rocks, and that all the

waters and aqueous vapors of the earth were produced by the chemical union of oxygen and hydrogen gases.

Now if the worlds and suns by means of the active principles of conduction and radiation are cooling, how was their former greater heat made and accumulated? Contraction, it must be borne in mind, cannot increase the store of heat. At best, it can produce it only as a sequence to loss, or as an effect of cooling, and in the process less heat is furnished by contraction than is radiated away. The actual fact of cooling and contracting spheres infers necessarily a time when the cooling, contracting body was much hotter and less dense, and points plainly to a time of heat climax. Prior to this heat climax in each radiating sphere its store of heat must have been accumulating. And there is but one natural process of accumulation, namely, by the continued impact of down-falling matter and its combustion.

Every self-shining star is an intensely heated body, outwardly burning, a very great but wholly natural fire. And every fire, small and great, grows by feeding it, by dropping into it fuel. A cooling sphere leads us back to its most heated period; and the preceding period of its history must have been a period of increasing the mass of its matter and its store of heat. The climax of highest possible temperature and greatest store of heat in a radiating sphere could not be a standstill point. Either the heat must be growing less by radiation, or the mass must be increasing by attracted heat-producing matter, showering and bombarding down out of the heavens.

The age of every heat-radiating sphere is indicated by the mass and density of its matter; the greater the heat-radiating mass, the longer the process of heat storage and mass growth, as a rule. The greater the mass of the sphere, the longer also will be the period of its cooling after the supply of fuel fails.

Previous to the highest temperature of a cooling sphere its store of heat must have been increased, by the fire-feeding mass-increasing process, from a beginning; and that beginning, if at the remotest possible time, was necessarily a beginning of tiny flame, the fuel elements being drawn together then and subsequently by attraction out of surrounding space. As we trace the great fires of nature backward through the world-cooling period, and the connected earlier heat-storing process, we come at last with scientific certainty to the beginning of each fire, each star, to the oldest possible flame of its first few atoms, drawn together by gravity and set on fire by chemical affinity. These star beginnings, before the flame could go out or the heat be lost, naturally were fed by more atoms and meteor-forming fuel attracted from the space behind. This continuous process, traceable by the indisputable fact of radiation, with its later diminishing and earlier increasing store

of heat, was the order of nature which formed the spheres, by means of the attracted particles and concentrating meteors of cosmic matter.

We have thus traced all matter that gravitates, all suns and worlds and the once separate parts that compose them, back to a space and time limit, to a time and condition of incoherency, to a cosmic "cloud" or "clouds" from which the material bodies of the universe began to be formed. But the beginning of the phenomena of gravitation must be accounted for.

Imagine this cosmic "cloud" of incoherent matter. Could it have been unlimited in extent, its particles at equal distances occupying infinite space?

If unlimited in its extent, the attracting forces of gravitation would have been in equilibrium and the particles of matter must have remained forever at rest. Incoherent matter occupying infinite space could not have attracted itself into masses and made the worlds of the universe.

But if the only alternative be accepted, namely, that the cosmic cloud was not infinite in extent, was itself surrounded by empty space, so that the cloud particles would naturally fall toward each other and form masses, how can we account for the fact which we have discovered, namely, that they everywhere *began* to fall together? Why had they not attracted each other before? They could not have been falling or drawing together from infinite space during the previous eternity, because of the force equilibrium involved in such an arrangement; and they could not have been falling longer than they were, for the reason that many centers of attraction were started, centers surrounded by centers—forming, attracting, growing stars surrounded by like stars. Certain intermediate lines between the star or sun of the solar system and the surrounding stars of its group would mark a limit from which matter could fall our way.

In view of the universal facts of conduction, radiation, and previous storing of heat by the integrating process, also of the natural limitations of both the sum and the source of heat, or of the fields of space (as divided by attracting star centers) from which attracted matter falling could furnish heat, we are forced to conclude that at a certain time the elementary particles now constituting the bodies of the material universe began to gravitate, began to be drawn together. But if the incoherent cosmic matter began to gravitate and integrate at some certain time, materialists must admit that prior to that time it lacked the power. Newton's First Law of Motion is an accepted principle in science—that every body, or particle, or mass of matter perseveres in its state of rest or of uniform motion in a straight line, except in so far as it is made to change that state by external forces.

Here is the process of integration, not yet complete, by all scientists observable—meteors falling nightly; a cloud of light-reflecting meteoric dust spectrographed as surrounding a star in the Pleiades; all integrated bodies of a limited size and age, leading back unquestionably to a time when all matter was in an incoherent homogeneous condition. Then the attraction of gravitation began to act. But if matter is mechanical, mindless, it is powerless to originate motion, or attraction.

Through the invariable action of universal forces we come to first action in the evolution of the cosmos. And first action, initiative, involves freedom, choice, the will to act cosmically of an infinite Free Agent—to whom we have traced all the formations and transformations, the entire order and power of nature.

Much of history, so-called, by man recorded, may not be credible; but the connected testimony of radiation, conduction, integration, and gravitation must be absolutely trustworthy.

The universe consists today of sunlit worlds and blazing stars whose furious flames are fed in part even yet by down-falling meteoric fuel, the more or less concentrated fragments of the cosmic cloud long balanced between stars and star groups in the depths of space. But the great fires of the universe are failing, and countless spheres have become cold and dark. The cooling process, by the principle of conduction and radiation, carries us back to a necessary climax of heat in every body in which it has been stored; and these greatest possible stores of heat in every sphere conduct us back through the long process of fire-feeding and star-building which gravitating cosmic matter required, to an earliest time possible for light and heat to be caused at the far separated star beginnings in the cosmic cloud, attraction centers where the bodies of the infant spheres of the universe began to be formed by the first action of gravity and chemical affinity.

Thus with no uncertain steps we have trodden nature's course backward till we stand "in the beginning." We have moved mentally into the cosmic cloud out of which the Universe was formed. Its measurless vastness spreads through "the deep" of space. The day has become night, and there are no stars. The suns have dwindled to tapers and gone out in primeval darkness. The ununited cosmic elements reach every way as far as the present stars and farther. Through all the exact compoundings and re-compoundings, through all transformations to the earliest formation, along all the distance passed over by the massing particles, back from the centers of attraction we have traced the elementary atoms, and have reached the nearer space fields and the remotest places from which they could have gravitated—and before beginning to gravitate the incoherent unattracted matter must have been at rest. Before the beginnings of integration and gravitating

motion, rest. And then out of the darkness and seemingly empty infinite distances something, everything—the manifestation of All Power—the universe drawing on out of the breath-like beginnings of motion.

That which occurred would have been materially or mechanically impossible. So the discovered beginning of universal gravitation discloses a pre-existing Infinite Energy, and shows the power in and behind all matter to be mental—*the kind of power that can initiate motion; that can act or refrain from acting.*

The scientist following the order of nature backward to the natural limit, to a discovered beginning, finds the mental kind of power in all beginnings of motion. And as it is absurd and unthinkable that each atom has an individual directing mind and that there were as many minds to agree as there were atoms in the universe, so it is wholly and supremely reasonable to conclude, in view of the connected forces and parts of the great whole, that the power is one Power and the mind is one Mind.

Is God, then, unknowable?

Beyond the ever-widening horizon of human knowledge, and beyond the cosmic circle and sum of things, there must always be an unexplored infinity; but the wisdom manifested in the material worlds of the seemingly boundless universe is God's wisdom and the power is God's power. The sum of all knowledge is therefore the sum of all knowledge of God.

The cosmic stream of energy, supplied at will from the Infinite, formed the present universe. When the cosmos is complete, and has served its purpose—when

> . . . the sun grows cold,
> And the stars are old—

still, progress. Look for the next cosmos impulse, and for new heavens to arise. "The Infinite and Eternal Energy" can never be exhausted. In the unfolding plan of God cosmos shall open out of cosmos, not in endless repetition but by the order of eternal evolution.

And man?

He is not a machine, to be scrapped. He need not be as the beasts that perish. His intellect is at home in the eternities.

SUNSPOTS AND THE PLANETS.

GEORGE F. KRONENBERGER.

Several attempts have been made to prove that the sunspots are caused by the influence of either one planet, or of all the planets, upon the sun. The planet or planets are said to act directly by displacing the sun's center of gravity and indirectly by the varying positions of the planets, which cause that displacement. Possible as this may seem from a physical view-point, the planets themselves, however, seem to furnish us with sufficient proofs of the fact that it is not they that are the cause of this phenomenon, but that its cause is to be sought for rather in some periodical but purely internal solar action. That this is so is to be seen either in the non-coincidence of their orbital periods with the sunspot cycle, examining either the planets singly or the resultant of the combined action of all possible groups, or it may be seen in positions which the planets have at some time occupied and which positions do in themselves contradict the possibility of such an effect. A few such data are given below, where we consider firstly, the major planets, secondly, the minor planets and lastly, combinations of the two.

The planets Jupiter, Saturn, Uranus and Neptune acting in combination cannot produce sunspots, because in 1804, when they were all together within a space of about 56°, there occurred a maximum period, but in 1788 they were so scattered that their forces could not have been combined as in 1804, and yet the former year likewise experienced a maximum period. Nor can these planets, when grouped in threes produce the spots, because 1, Jupiter, Saturn and Uranus in 1804 were well together at a maximum period, but in 1837 their forces could not have been united in any way as above, but still there occurred another such period; 2, Jupiter, Saturn and Neptune were grouped together at a minimum period in 1843, but in 1867 at another such period they were widely separated; 3, Jupiter, Uranus and Neptune were together in 1843 at a minimum period, but in 1878 they were separated, though this too was a minimum period; 4, Saturn, Uranus and Neptune were together at the minimum period of 1810, but they were widely separated at a like period in 1867. The major planets considered in groups of twos cannot be said to cause the spots, because

Jupiter and Saturn were together at minimum of 1784,
but near quadrature at minimum of 1867,
Jupiter and Uranus were together at maximum of 1804,
but near quadrature at maximum of 1848,
Jupiter and Neptune were together at maximum of 1830,
but near quadrature at maximum of 1848,
Saturn and Uranus were together at maximum of 1804,
but near quadrature at maximum of 1843,
Saturn and Neptune were together at maximum of 1848,
but near quadrature at maximum of 1870,
Uranus and Neptune were together at maximum of 1830,
but near quadrature at maximum of 1778,

and since they could not produce the same result in both these positions, they could not have effected the spots. Considered singly, these planets cannot be the cause of the spots, because, when the list of the sunspot periods is arranged according to the number of spots, the distance of none of these planets from its perhelion or aphelion point (or from any other point fixed upon its orbit) will fall into a series such as should follow, were the one the effect of the other. For example—Jupiter at a period of 140 spots (1870) was about 39° from perihelion, at a period of 9 spots (1784) its distance from that point was about 54°, but at a period of 2 (1878) its distance was about 65°, showing a lack of agreement. Saturn at a period of 142 spots (1788) had a distance of about 100°; at a period of 9 spots (1784), a distance of about 149°; at a period of 0 spots (1810) its distance was about 102°. Uranus at a spot period of 142 (1788) had a distance from perihelion of about 38°; at a period of 10 spots (1843), a distance of about 178°; while at a period of 148 (1837) its distance was about 142°. Neptune at a period of 140 was distant (1870) about 21°; at a period of 0 (1810) its distance was about 146°; while at a period of 155 spots (1778) its perihelion distance was about 137°.

The minor planets, Mercury, Venus, the earth and Mars do not produce the spots when acting together, because their relative positions change too rapidly to account for the changes on the sun. For example—letting them all begin at one point on the celestial sphere, each revolving in its own orbit, after 90 days they would be spread over an angular distance of about 135°, Mercury having in this time made more than one complete revolution. So great a change in 90 days could not then account for a period of solar quiet such as we have had since June 1912, nor could it account for such periods of comparative quiet as these: May to August 1905, January to April 1910, December 1909 to May 1910 or for other such periods. When grouped in threes, these

planets show a like result, thus—1, Mercury, Venus and the earth, each in its own orbit, and starting apparently at one point in the celestial sphere, would in a period of 35 days occupy positions, which counting their starting point as 0° would be as follows: Mercury 145°, Venus 56°, the earth 34°. This change in position could not account for such unchanging periods as May to September 1905, March to July 1907, January to April 1908, nor for other such periods; 2, Mercury, Venus and Mars after 50 days would hold such positions as—Mercury 205°, Venus 80°, Mars 26° and could not, therefore, after such a change account for such unchanging solar periods as that from May to August 1905, that from March to July 1907 nor for others; 3, Venus, the earth and Mars, after a period of 140 days, would have travelled from 0° to 224°, 138° and 73° respectively, and after this change could not account for periods of solar quiescence such as that from the year 1911 to 1913 (excepting here the short-lived spot in June 1912); 4, Mercury, the earth and Mars would in 90 days hold such positions as—Mercury 8°, Earth 88°, Mars 47°, the first having made a complete revolution plus eight degrees. Such a change could certainly not account for such almost unchanging solar periods as May to August 1905, January to April 1910, nor for others. Now, combining the forces of any two of the minor planets, we see also that this result has no relation to any sunspot period for Venus and Mercury are in the same relative position, one to the other, every 144.3 days; Mercury and the earth, every 115.8 days; Mercury and Mars, every 100.8 days; Venus and the earth, every 587.2 days; Venus and Mars every 334.5 days; the earth and Mars, every 777.5 days. These recurrences, we see, cannot account for the 11-12 year solar period. In a like manner does the shortness of the periods of revolution of these planets show that no single one of them, acting alone, can be the cause of the spots, which run through a cycle of many years.

Should the deficiency in the forces of the major planets be supplemented by those of the minor planets, their approximate relative positions would then be repeating themselves in too short a time to be the cause of sunspots, for Mars, whose orbit is the largest among the orbits of the minor planets, will make six revolutions about the sun in the same time required for Jupiter, whose orbit is the smallest of the orbit of the major planets, to make but one.

As for the planetoids—their influence upon the sun need scarcely be considered, when it is found that the planets themselves exert no such influence.

Having thus eliminated the planets from the possible causes of sunspots, we are left to search for their real cause in a force acting within the sun itself and making itself visible in a periodic effect. To suggest

such a cause, at present, would, of course, be a matter of mere speculation, but forces acting upon other suns may perhaps give us a clew as to what is taking place upon our own. If, for instance, we were to consider the cause of the Novae as a force acting from within the bodies of the stars, we could then look upon the sun spots as a weak demonstration of a force which may some day assert itself in all its power, causing the sun to flare up as a Nova. Thus would the sun and not Saturn devour his children.

THE NORTH POLE.*

WILLIAM F. RIGGE.†

The poles of the earth are, in the mathematical as well as in the ordinary sense of the word, singular points; that is to say, they possess many essential features which do not apply in any way to other points on the earth's surface.

By definition the poles are the extremities of the earth's axis. The earth, as we know, is a big ball and is turning. That it is a ball, or approximately a sphere, is proved by the appearance of vessels at sea, by the equal dip of the horizon in all directions, by the different aspect of the starry heavens as seen from different points on its surface, by the shadow it casts upon the moon in a lunar eclipse and lastly by extended measurements of its surface. That it is in rotation is proved by the classical experiment of Foucault's pendulum, by the gyroscope and the deviation of projectiles, and especially by the science of celestial mechanics, which establishes its rotation as an essential postulate.

We know also that the earth is carried forward bodily as a whole, and that its center moves in a well defined orbit about the sun. This feature does not interest us at present and we shall dismiss it with the statement that the earth runs a little over a million and a half miles a day, and in so doing turns round once on its axis in moving forward about two hundred times its own length. This, as we see, is a very moderate ratio.

The poles, as was said, are the extremities of the axis about which the earth turns. This axis is often said to be imaginary, as opposed to real, and when we say real, we take the case of a mounted globe or a wheel turning on an axis, or axle, in fixed journals. The earth of course has

* Reprinted from *The Creighton Courier*, June 15, 1913.

† Professor of Physics and Astronomy, The Creighton University, College of Arts and Sciences; Director of the Observatory.

no real axis in this sense, as it is freely suspended in space. When, therefore, we say that the earth's axis is imaginary, we mean that it is exactly like that of a ball, which we may throw up into the air, and to which we may give a more or less rapid spinning motion. This spinning ball is then said to rotate, or turn about an axis, every point in it and on it, except those on the axis itself, moving in a true circle of its own. The center of each of these circles is on the axis of revolution at the foot of the perpendicular dropped to it from the given point. The points farthest away from the axis are said to lie on the equator; they form the circumference of a circle obtained by cutting the sphere by a plane through its center at right angles to its axis.

It is evident that all the points in and on the earthly sphere must move together in such a way that their relative positions are not changed nor the sphere distorted. Hence, while they all have the same angular speed about the axis—that is, they all run the circuit of their own circles in the same time—their linear speed, their miles per hour, must depend upon their distance from the axis. Thus at the equator every point moves about 24,000 miles in twenty-four hours; that is, about a thousand miles an hour. Omaha is about 6000 miles from the earth's axis and rotates, therefore, at the rate of about 750 miles an hour. As the poles are on the axis itself they do not rotate at all; their linear speed is zero. This, therefore, is the first reason why they are called singular points.

The consequence of this immobility is a total loss of the so-called centrifugal force. This force is the apparent tendency of a point to recede from the center of revolution; it is in reality a case of inertia, according to which it tends to retain its direction and remain on the tangent line.

At the equator this tendency is a maximum and amounts to 1-289th of the gravitational attraction. So that the weight of bodies is lessened there by one pound out of every 289. As a consequence the movable constituents of the earth's surface, the air and water, have receded from the axis and approached the equator, and have there accumulated in a ring around the latter thirteen miles thick. The equatorial radius of the earth is, therefore thirteen miles longer than the polar radius. This difference between the radii of different parts of the earth's surface is a gradual one. The polar radii are the shortest, and the rest increase in length gradually until we reach the equator, so that a meridian section of the earth is nearly a true ellipse, with its minor axis running through the poles and its major axis in the plane of the equator.

The poles of the earth are, therefore, unique in two respects—they do not rotate and they are nearer the earth's center than the other parts

of the surface. For both reasons the weight of bodies is a maximum at the poles. It is one pound out of every 190 greater than at the equator.

These results have been obtained principally by means of the pendulum. We know that gravity is the only force that moves a pendulum, and that the time it takes to complete a vibration is absolutely constant as long as the force of gravity and the length of the pendulum are the same. By transporting the same pendulum, therefore, to various parts of the earth's surface we can determine the variation of gravity, and thus find the shape of the earth. This has been done already in so many places that we have a pretty accurate knowledge of the shape of the earth. It is by inference from these results that we know what the force of gravity is at the poles. It would, however, be a most desirable consumation of these researches to set up such a pendulum at the pole itself.

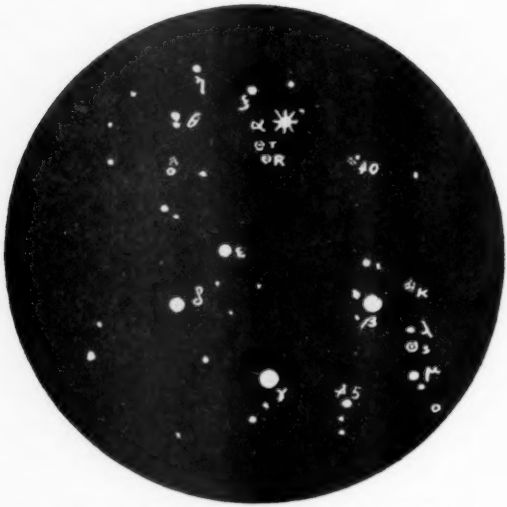
THE SOUTHERN CROSS.

BERNARD THOMAS.

The Southern Cross has for those south of the line a national as well as a scientific interest. Here in Tasmania, as well as in the whole of Australia, there is a patriotic sentiment attached to this small but brilliant constellation. It adorns our flag and is quite an emblem of the Commonwealth and familiar to the man in the street as the Great Bear or Dipper with you. Although the constellation is a small one it is situated in brilliant surroundings. The two pointers, α and β Centauri (two brilliant first magnitude stars) together with bright second and third magnitude stars in Centaurus and Musca and the adjacent Argo, provide a suitable setting. Besides this the Milky Way, which passes through the cross, is here specially luminous. The Cross itself consists of four bright stars; α, magnitude 1.0, and β, magnitude 1.50, are both white Orion stars; γ, magnitude 1.60, an orange star of type M; δ, magnitude 3.08, white (between Orion and Sirian). Besides these four there are; ϵ, magnitude 3.57, an orange star of type K; ζ, magnitude 4.26 (between Orion and Sirian); η, magnitude 4.30 (between Sirian and Solar); θ^1, magnitude 4.5 (separated from θ^2 by about 10′ of arc), and many others of lesser magnitude (see map of brighter stars).

It is when the region is carefully studied with a telescope that we realize the full beauty and interest of this portion of the sky exposed

to our gaze. Only a two-inch refractor, with powers of 50 and 70 diameters, has been used by the writer, but to anyone, even with this modest equipment, the whole heavens is a storehouse of never-ending interest and delight.



MAP OF THE BRIGHTER STARS IN THE SOUTHERN CROSS.

α Crucis ($12^h\ 21.6^m$; — 62° 36′). This bright star is the very finest double in the whole heavens. Magnitudes 1.58 and 2.09, angle 117°.3, distance 4″.7, both white (Type B1). As they shine in the field one cannot fail to admire this superb pair; and this is not all, for at angle 201°.8 and distance 89″.8 is another star of fifth magnitude of a greyish yellow color. Around at a greater distance twinkle stars of lesser magnitude. The bright components are easily separated with power 40, but a power of about 150, which I sometimes use, shows them wide apart. They are probably physically connected; they have the same proper motion, but no orbit has so far been found. They shine at an immense distance and so they really may be very widely separated. A parallax of only 0″.05 has been detected by Gill, which corresponds to a distance of 65 light years.

γ Crucis ($12^h\ 26^m.2$; — 56° 36′). This fine orange coloured star of magnitude 1.60 has a fifth magnitude green or bluish green companion at angle 34°.9; distance 101″.3. The colours are the effect of contrast. The primary is type Ma and suspected of varying slightly, though it always seems to me as bright as β (1.50).

μ Crucis ($12^h\ 48^m.7$; — 56° 38′). This star is a very fine double for small telescopes and a low power. The components are of magnitudes 5 and 6, angle 17°.4, and distance 34″.3; colours white and dull gray. A sixth magnitude star is closely north following.

45 Crucis ($12^h\ 40^m.6$; — 55° 56′). The number is Gould's; a fifth magnitude star; has a ninth magnitude companion at angle 163°.8 and distance 54″.2; very evident with 2-inch, power 70.

Besides these easily found double stars there are many others. I note the region north of α Crucis as containing many wide pairs. Also north of $\theta^1\theta^2$ is a field of many wide doubles near. Here is Δ (Dunlap) 117 ($11^h\ 59^m.0$; —62° 26′) about 1° north of θ, magnitudes 8 and 8; angle 147°.9, distance 14″.4. There is a faint star about 10^m or 11^m at angle 19°.1, distance 24″.8; this I can see distinctly on a clear night but it seems to me that one of the brighter components is a little fainter than the other.

Δ 127 ($12^h\ 54^m.0$; — 55° 21′) is found about 1° north of μ; magnitudes 8 and 9, angle 126°.3, distance 16″.3; both yellowish.

But double stars are not the only objects of interest for there are several clusters and the Milky Way.

The galaxy is very bright in this region. The brightness is due to comparatively bright stars, 7 to 9th magnitude. From a narrow band near λ Centauri it opens out to enclose the foot of the cross (α, δ and β) and the northern part of Musca, as it does so leaving a large gap, the "coal sac" closely following α, devoid of luminosity. This "coal sac" covers about 50 square degrees; to the eye it seems very dark, only one faint star* —the Oasis star (40 Crucis of Gould)—being near its southern edge. I am told that 1° following this is a star of about 6.5–7 magnitude, not now visible to naked eye, which was at the time Behrmann made his catalogue (about 1874) of magnitude 5.7 and conspicuous. The darkness of this region may be largely effect of contrast, for examination with the telescope shows more 8^m–10^m stars than one would expect. In photographs of sufficient exposure the coal sack outlines are obliterated. Perhaps the explanation is that we are here looking through the galaxy to the stars beyond. It is interesting to note that in this area and close to 40 Crucis is a tiny cluster, of a rectangular form, of ninth or tenth magnitude stars (N.G.C. 4609? $12^h\ 36^m.5$; —62° 25′. "Cluster pretty large, pretty compressed, extremely extended, stars 10 magnitude"). The writer shares with others the view that the galaxy is not further than some of the brighter stars and it seems quite probable that, say, β Crucis is in the midst of it or even further away. Hence the difficulty of finding a parallax for this bright star, which has almost the same proper motion (in extent if not in direction) as α Crucis.

* Mag. 5.98, S.H.P.

The cluster κ Crucis is close to β, a little south, a little following. It consists of seven stars, 7–8 magnitude, arranged like a letter A, the brightest star at the vertex; a red star closer to one side than the other indicates the horizontal line; the star on the preceding side at the base has another star of about $8\frac{1}{2}^{m}$ close to it and there is also a 9^{m} star near the brightest one. Close to the base on the following side is a cloud of small stars from ninth to eleventh magnitude. It is only on a very clear night that I can see these glittering. There is generally some milky opalesence in this portion of the cluster. It has been stated that the relative positions of some of these stars have altered since Herschel's time. Preceding the cluster is a seventh magnitude star of pale orange color. There is another beautiful cluster easily found north of $\theta^{1}\theta^{2}$; this is N.G.C. 4103 or 291 of Dunlop ($12^{h}\ 1^{m}.5$; $-60^{\circ}\ 41'.3$.) "Cluster, pretty large, pretty compressed, irregularly round, stars 10-14 magnitude." It consists of a cloud of very small stars some of the brighter of which are distinguishable in the 2-inch; the rest show their presence by nebulous light. In the same field are many wide pairs and brighter stars.

The last objects of interest are the variable stars *S*, *R* and *T*, whose positions I have indicated and whose periods and magnitudes will be found in this journal.

Glenorchy, Tasmania.

NIGHT.

Thy retinue, the constellations, Night,
With stately march across the heavens go!
And planets shine afar with steady light,
While countless hosts of starry systems show
Within thy Galaxy, the Milky Way.
The kindly Moon moves graciously along,
And turns, O Night, thy darkness into day—
For Queen is she of all the shining throng!
Such wondrous orbs as thou revealest, Night,
Can men yet doubt a Pow'r controlling all?
Long ere these mighty suns have lost their light,
What scenes and changes shall our souls enthrall?
Unharmed, 'mid wreck of Time, shall they not stay,
Till thou, O Night, art merged in Endless Day?

ALICE BERLINGETT.

THE PARALLAX OF NOVA GEMINORUM (2).

FREDERICK SLOCUM.

Nova Geminorum (2) was discovered by Enebo at Dombaas on March 12, 1912. The maximum negative parallactic displacement of the star occurred shortly after that date. A series of plates with the 40-inch refractor for the determination of its parallax was begun on March 18. Four plates were secured during that month, each having two exposures. Six months later, when the star was approximately six hours west of the sun, six more plates were obtained at the time of the maximum positive displacement. And again six months later, in March 1913, five more plates were added at the second negative epoch.

When the first plates were exposed in March 1912, the star was of about magnitude 5. Six stars of nearly uniform brightness and symmetrically arranged around the Nova were selected for comparison stars. The mean magnitude of these stars is about 9.5.

In order to avoid errors due to difference in magnitude between the Nova and the comparison stars, the rotating disc was used with the sector opened about 10°, which reduced the light of the Nova by a little more than four magnitudes. As the Nova grew fainter the sector was opened wider and wider, until finally when the Nova was nearly down to the ninth magnitude, the rotating disc was removed altogether. Thus throughout the whole series the size of the image of the Nova on the plate was kept practically constant.

A least square reduction of the measures of the 30 exposures gives for the relative parallax of the Nova

$$\pi = +0''.006 \pm 0''.007$$

and for the proper motion in right ascension

$$\mu_\alpha = -0^s.0003 \pm 0^s.001$$

The proper motion in declination was derived from seven plates by a less rigorous method.

$$\mu_\delta = +0''.036 \pm 0''.016$$

The above value of π is relative to the weighted mean parallax of the comparison stars. From Kapteyn's table, the average value of the parallax of stars of the magnitude of these comparison stars is $+0''.005$. Applying this we have for the absolute parallax of Nova Geminorum (2).

$$\pi = +0''.011$$

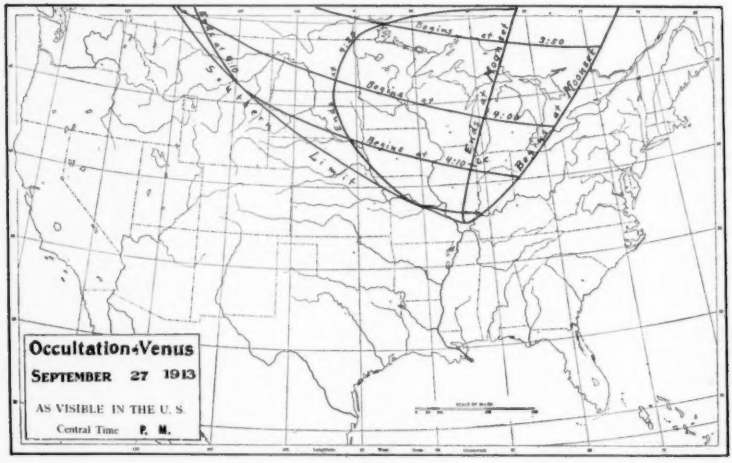
corresponding to 296 light years.

Yerkes Observatory,
May 15, 1913.

THE OCCULTATION OF VENUS OF SEPTEMBER 27, 1913, AS VISIBLE IN THE UNITED STATES.

WILLIAM F. RIGGE.

The only planetary occultation visible anywhere in the United States during the present year 1913, will be that of Venus on September 27, and even this will occur under very adverse circumstances, since it will be confined to a small section of the country and will take place



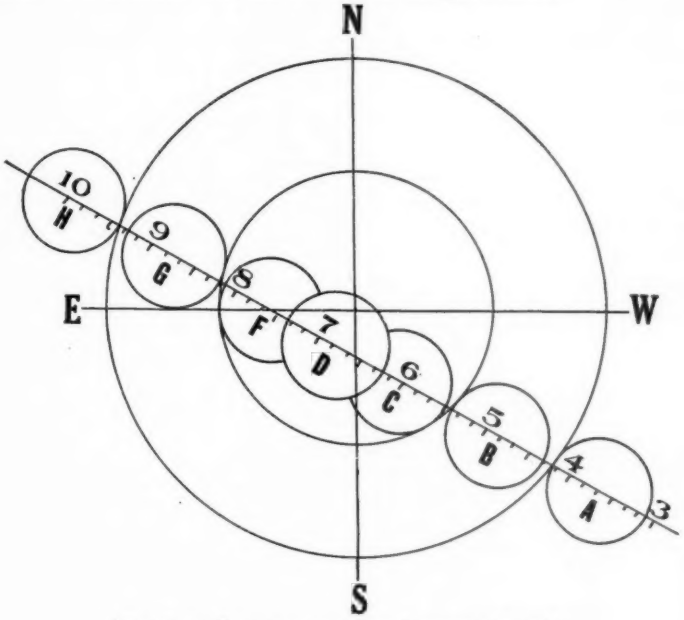
in the day time with the moon very low in the sky. The annexed map gives the desired information, which is probably sufficiently evident upon inspection. Owing to the extremely low altitude of the moon, the position of the curves is only approximate. The point L C denotes the last contact.

Creighton University Observatory,
Omaha, Nebr.

THE TOTAL ECLIPSE OF THE MOON SEPTEMBER 15, 1913.

WILLIAM F. RIGGE.

The total eclipse of the moon of September 15, 1913, will be an almost identical repetition of the one of last March 22. It will occur in the twilight near the time of sunrise and will be visible only in the western states. The annexed diagram will tell us the particulars.



THE TOTAL ECLIPSE OF THE MOON SEPTEMBER 15, 1913.

The largest circle with its cardinal points N E S W is the earth's penumbra, the smaller one concentric with it being the umbra or shadow. The seven smallest circles represent as many positions of the moon at important moments. When the moon's center is at A at 3:40 A. M. central time, the moon enters penumbra. At B at 4:52 the moon enters shadow. At C at 6:01 the total eclipse begins. At D at 6:48 there is middle of the eclipse. At F at 7:35 the total eclipse ends. At G at 8:44 the moon leaves shadow. And at H at 9:56 the moon leaves penumbra.

The diagram must be held in such a way that the line NS inclines to the right, the exact amount depending upon the observer's latitude and the moon's local hour angle.

The magnitude of the eclipse in 1.43, that is, if the moon had a diameter 43 per cent larger, it would still be just totally eclipsed. It may be of help to know that the moon sets at Omaha at 6:04, three minutes after the beginning of the total eclipse, and that the sun rises at 6:05.

Creighton University Observatory,
Omaha, Nebr.

CONSIDERATIONS ON THE PHYSICAL APPEARANCE OF THE PLANET MARS.*

E. M. ANTONIADI.

In the year 1877, our knowledge of the markings which variegate the surface of Mars was in a very satisfactory condition. A series of excellent observations by Dawes, Lockyer, Lassell, Kaiser, Burton, Green, and others, had disclosed the true natural structure of the spots on that

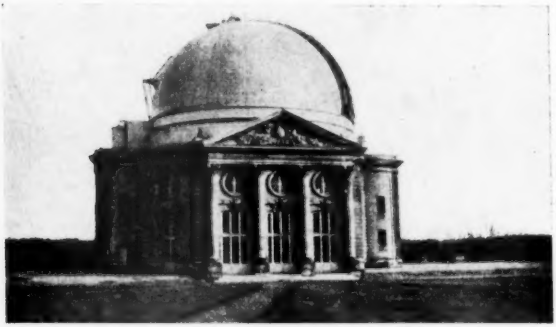


FIGURE 1. View of the Great Dome of the 33-inch Refractor at Meudon. Height of the ground above sea level, 533 feet.

planet. The question thus appeared definitely settled, when it was troubled by the Italian astronomer Schiaparelli,† who announced that linear objects, to which he gave the name of channels, or canals, were furrowing the so-called continental regions of our neighbour in space.

* Reprinted from *Knowledge* May, 1913.

† This view of the discovery of the canals was given by Mr. Maunder, in *Knowledge* for 1894, p. 249.

During the apparitions of Mars following the year 1877, the Milan observer continued and extended his discoveries; his later maps seemed practically covered with spider's webs; while the zeal and discernment of his followers could number no less than one thousand different canals on the yellow or grey expanses of the planet.

Gigantic watercourses, mostly running along great circles of the sphere and, consequently, appearing straight near the center of the disc, continued to look straight in Italy even when nearing the limb of Mars. A geometrical cross of canals in the land called Hellas was seen attended with four symmetrical bright specks of light, recalling somehow to memory the *In hoc signo vinces* of the emperor Constantine. Canals scores of miles wide, and hundreds of miles long, were observed in a few days, or even hours, to double, either by the formation of a parallel band, or by the disappearance of the original canal, and by the formation of two new parallel streaks separated by hundreds of miles. Nor were hesitations in these doublings neglected to be put on record, since canals were seen to be alternately single and double on the same night.

To account for these wonderful phenomena, the vast powers of Nature were found totally inadequate; and thus it was that Schiaparelli was led to enunciate the idea of the artificial origin of the canals, conceiving the larger of them to be composed of six different watercourses, whose dykes would be opened now and then by the Martian minister of agriculture.

FIGURE 2. The Laestrygon. 1896, June 12.

FIGURE 3. The Jamuna. 1894, August 27.

Single and double Canals of Mars, as glimpsed for a quarter second by the writer.

Speculations of such a character were eagerly embraced by M. Flammarion and other popular Continental writers. Yet it is to be regretted that the originator of this artificial theory, and his imitators, have failed to do the utmost with their cherished idea. For, inasmuch as the canals appear straight about the central meridian, and also when

carried by rotation near the limb, it is obvious that the Martian engineers would be constantly engaged in rapidly digging and destroying their watercourses, so as to make them look always straight to the observers on the earth.

It is to the credit of British science that the results of Schiaparelli were, from the very onset, strongly controverted by English astronomers. In 1879 Green boldly questioned the reality of these canals. In 1882 Mr. Maunder and Mr. (now Sir) William H. M. Christie rightly insisted on the error of Schiaparelli in using too high powers. But the honour of first recognizing the true nature of the minor detail of the planet is due to Mr. W. F. Denning, who announced, as far back as 1886, that the continents of Mars show here and there some irregular streaks, presenting frequent interruptions and condensations. As is wont in such cases, this statement attracted no attention at the time; and it was only several years later that it received full confirmation at the hands of Professors Young, Barnard, Hale, and the writer, all observing with very powerful telescopes. And when we recollect that Mr. Denning used in this enquiry only a ten-inch reflector, and that he made his innumerable other discoveries in an unfavourable climate, and under difficult circumstances, we deem it only just to consider him as the greatest of all modern observers.

FIGURE 4. Schiaparelli 1883-1884

FIGURE 5. The Writer 1909

The "Canals" Laestrygon, Antaeus and Tartarus, as seen in an aphelic apparition with an 8½-inch, and in a perihelic apparition with a 33-inch Refractor.

FIGURE 6. Schiaparelli 1883-1884

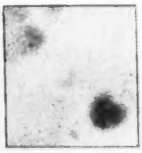


FIGURE 7. The Writer 1909

The "Canal" Eosphoros in an aphelic apparition with an 8½-inch, and in a perihelic apparition with a 33-inch Refractor.

The canal problem, thus solved by observation, was next approached from the point of view of theory. In 1894-1895, Mr. Maunder laid stress, in these columns, on the error of believing that our telescopes reveal to us the ultimate structure of the surface of the planet. As a consequence, he expressed his conviction that the canals are only the summation of a complexity of detail, comparing them with the linear appearance to the naked eye of an irregular stream of sunspots. This is the key to the whole question. "I quite agree with you," says so high an authority

as Professor Barnard, in a letter to the writer, "in respect to Mr. Maunder's work in trying to clear up the tangle about the canals of Mars. I think he has thrown much light on the subject."

FIGURE 8. September 18.
V. Fournier.
Jarry Desloges Observatory.
11½-inch Refractor.

FIGURE 9. September 20.
The Writer.
Meudon Observatory.
33-inch Refractor.

FIGURE 10. October 5.
From a photograph.
by Professor Hale.
60-inch Refractor.

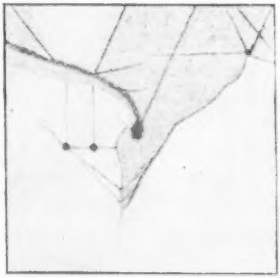


FIGURE 11. November 3.
Professor Lowell.
24-inch Refractor.
stopped down to some 15 inches.

Views of Syrtis Major and Lacus Moeris 1n 1909 with various telescopes.

Many able observers believed that Schiaparelli had imagined all his system of spider's webs. But this is quite unfair, as, with the excep- of an abuse of magnification, the errors of Schiaparelli were errors of judgment, and not of observation. Although the constant use of high powers made him lose the half-tones of Mars, his outlines of the dusky areas are usually more accurate than anything ever drawn with a telescope of the size he used. As a patient record of fleeting impressions, his results stand unrivalled; while his splendid triangulation of the Martian surface has victoriously resisted the test of time.

An unsympathetic feature of most planetary drawings is the regularity of their markings. Scientific candour is partly responsible for this, as the truthful observer will avoid the impossibility of sketching complex irregularities which he is only glimpsing, rather than introduce elements of doubt in his delineation. A less excusable reason for geometrical outlines may be sought in a widespread disregard of angular diameters. In fact, areographers too frequently forget that Mars is usually seen as a six penny piece held at the distance of two feet from the eye; and that what is sharp on such a small disc, so far off, ought to be represented as exceedingly vague on drawings three inches in diameter, seen at the distance of one foot only.

The student who passes many consecutive hours in the study of Mars with medium-sized instruments, is liable to catch rare glimpses of straight lines, single or double, generally lasting about one quarter of a second (see Figures 2 and 3). Here we have a vindication of Schiaparelli's discoveries. But their deceitful character will obtrude itself on the observer using a large telescope, when, in the place of the lines, he will hold steadily, either a winding, knotted, irregular band, or the jagged edge of a half-tone, or some other complex detail (see Figures 4 to 7).

In their anxiety to prop their views against natural law, believers in the reality of the linear canals have presumed to champion the alleged superiority of small over large telescopes; and this either in revealing planetary detail, or in separating close double stars. But the attempt has been defeated, both by theory and observation; (*a*) by theory, because of the law of diffraction, which proves that the defining power of a telescope increases with its aperture; and (*b*) by observation, from the evidence of the facts themselves. A comparison of the appearance of Syrtis Major on Mars with various instruments in 1909, when the weaker telescopes revealed inexistent lines while failing to show the coarsest details (see Figures 8 to 11) will establish forever their hopeless inferiority. Nor was the smaller instrument more fortunate on double stars. A spurious satellite to Sirius was discovered and measured in an impossible position in 1896, with a refractor of moderate power. But when the question of finding the true satellite was seriously raised, the discovery was naturally made with the thirty-six inch equatorial of the Lick Observatory, one of the most powerful instruments in existence.

Thus it is that diffraction fetters the efficiency of small telescopes; and their comparison with large ones is as childish as the attempt to bombard a fortress twenty miles off with guns whose range is only eight.

Such the errors foisted on the scientific world, and such the arguments leading to their final refutation. Yet truth will seldom receive acceptance without strenuous opposition. The laws of perspective will again

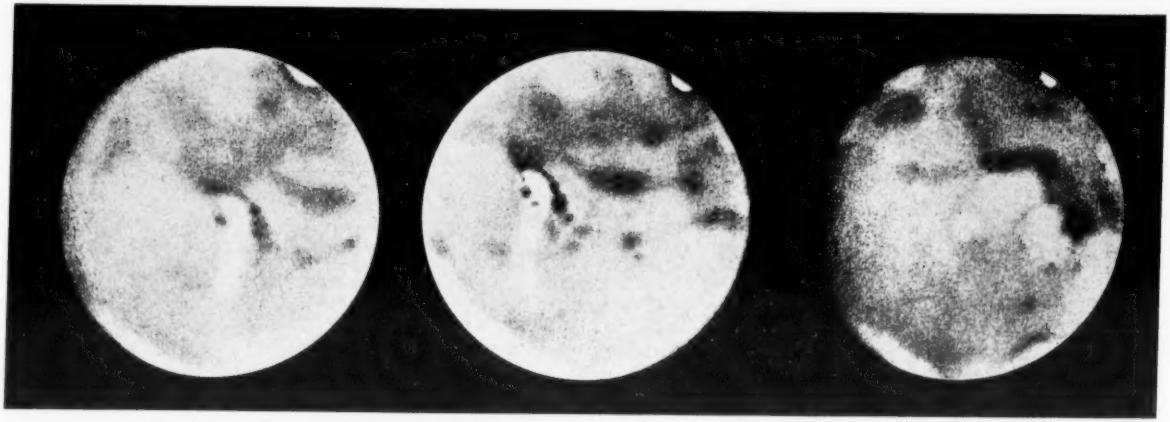


FIGURE 12.
1911, October 28^d 22^h 19^m.
Longitude = 58°.

FIGURE 13.
December 4^d 22^h 0^m.
Longitude = 87°.

FIGURE 14.
October 20^d 21^h 35^m.
Longitude = 126°.

OBSERVATIONS OF MARS IN 1911, MADE BY E. M. ANTONIADI, F.R.A.S., WITH THE 33-INCH REFRACTOR OF THE MEUDON OBSERVATORY, MAGNIFYING 320, 540, AND 810 DIAMETERS.

FIGURE 15.
October 17^d 21^h 55^m.
Longitude = 152°.

FIGURE 16.
October 14^d 23^h 0^m.
Longitude = 195°.

FIGURE 17.
October 14^d 21^h 30^m.
Longitude = 255°.

OBSERVATIONS OF MARS IN 1911, MADE BY E. M. ANTONIADI, F.R.A.S., WITH THE 33-INCH REFRACTOR OF THE MEUDON OBSERVATORY, MAGNIFYING 320, 540, AND 810 DIAMETERS.

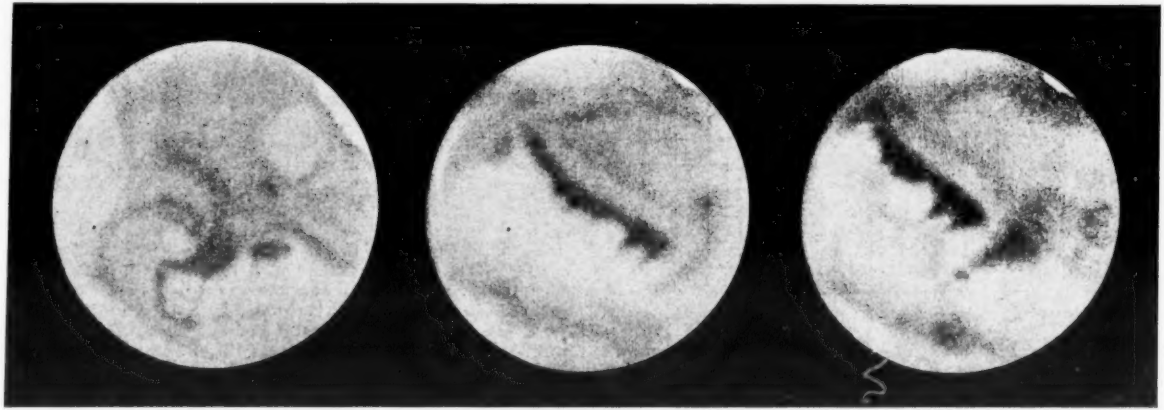


FIGURE 18.
November 13^d 22^h 45^m,
Longitude = 282°.

FIGURE 19.
November 6^d 22^h 15^m.
Longitude = 337°.

FIGURE 20.
November 3^d 21^h 48^m.
Longitude = 357°.

OBSERVATIONS OF MARS IN 1911, MADE BY E. M. ANTONIADI, F.R.A.S., WITH THE 33-INCH REFRACTOR OF THE MEUDON OBSERVATORY, MAGNIFYING 320, 540, AND 810 DIAMETERS.

be curbed by the evidence of lines appearing straight in all positions of a rotating globe. Some observers will continue proclaiming the superiority of small telescopes. Ponderous volumes will still be written to record the discovery of new canals. But the astronomer of the future will sneer at these wonders; and the canal fallacy, after retarding progress for a third of a century, is doomed to be relegated into the myths of the past.

KANT AS AN ASTRONOMICAL THINKER.

HECTOR MACPHERSON, Jr.

The fame of Immanuel Kant as the founder of a school of philosophy has overshadowed almost entirely his fame as an astronomical thinker. The mind of Kant was a many-sided one. As a philosopher—as is well known—his name ranks among the greatest of all time; had he concentrated his attention on science, he would probably have gained a very high reputation. His astronomical investigations, although he abandoned them at an early age, were truly remarkable and in the light of present day knowledge it is both interesting and profitable to consider Kant's cosmology and cosmogony and to notice in how many instances Kant anticipated modern discoveries.

Kant's astronomical writings are contained in two essays: (1) "Examination of the question whether the earth has undergone an alteration of its Axial Rotation," being a prize essay for the Berlin Academy of Sciences in 1754; (2) "Universal Natural History and Theory of the Heavens, or an essay on the Constitution and Mechanical origin of the whole Universe, treated according to Newton's principles." This was published by Johann Friedrich Petersen, Königsberg and Leipzig in 1755. The publisher became bankrupt, however, and as has been pointed out by Borowski the work "had the peculiar fate of not coming into the hands of the public, nor even of King Frederick II, to whom it was dedicated. Thus for years the book remained in obscurity. In 1763 in one of his philosophical works Kant included a summary of his work of 1755. This summary soon came to the notice of the well-known speculator Lambert.

In his essay on the earth's axial rotation, Kant discusses the question of an alteration of the terrestrial day. Finding that there are no historical grounds for such a supposition, he turns to a theoretical consideration. "The Earth" he says "turns unceasingly round its axis with a free

motion which, having been impressed upon it at once for all the time of its formation, would continue thenceforth unaltered for all infinite time and go on with the same velocity and direction, did no impediments or external causes exist to retard or to accelerate it." He finds an external course in the action of the tides and he remarks that "it deserves to be carefully considered whether this cause is not capable of bringing about some alteration of the rotation." After discussion Kant finds that tidal friction acts to retard the earth's rotation. Then he remarks that "if the earth is approaching the cessation of its rotation with constant steps, the period of this alteration will be completed when its surface will be in relative rest as regards the moon, i.e., when it will turn round its axis in the time that the moon takes to revolve round it and when it will consequently always turn the same side to the moon....If it were fluid through and through to its center, the attraction of the moon would bring its axial rotation in a very short time to this required residue. This at once brings before us the cause that has compelled the moon in revolving round the earth to turn to it always the same side." This remarkable conception closes Kant's masterly paper, an anticipation of the tidal friction theory mathematically worked out by the late Sir G. H. Darwin.

Kant's nebular hypothesis is the best-known part of his astronomical speculations. This is outlined in his "Universal Natural History." The nebular hypothesis in general outline is due to Kant, Laplace and Herschel, working independently; but nevertheless, the three theories differ considerably. Kant's speculation is of much earlier date than those of Laplace and Herschel, and we can only marvel at the wonderfully sagacious nature of his enquiry. Both the theories of Kant and Laplace agree in one point. The two thinkers postulate a primitive nebula, but in detail the theories are almost entirely different. Kant for instance, has no need to assume the existence of rings. He supposes that the primitive chaos divides itself up into isolated masses. Laplace's nebula is a true gas, while that of Kant is composed of a large number of independent particles circulating round the center of gravity. Von Oettingen, editor of Kant's works, brings out the difference very clearly in the following words:—"Kant starts from the primitive nebula in the Universe; Laplace from the nebular disc of our Solar System already in rotation. Kant makes suns and planets arise out of certain regions of space, through gravitation; Laplace makes masses and rings detach themselves from the central body through centrifugal force." On the whole, then, Kant's theory is more in harmony with modern thought than that of Laplace. This is noticeable in two particulars: (1) Kant's idea of centers of condensation in the primitive nebula is more in accord with recent investigation than Laplace's ring theory. It is certainly

more in harmony with the recent speculations of Chamberlin and Moulton, based on the study of spiral nebula. (2) While Laplace's theory explained only the evolution of the Solar System, Kant's was all embracing. It was a theory of the evolution of the Universe. In this respect, it was more in accordance with the speculations of Herschel on the development of nebula into stars. The late Professor Hastie, the latest translator of Kant, claims that Laplace's theory "shows no such insight as Kant does into the genesis of additional heat by the process of contraction; and it presents no attempt to account physically for the movements of rotation. On almost every important point at which Laplace's hypothesis has been called in question, Kant shows a singular freedom from mere theoretical prepossessions and a remarkable conformity with the latest empirical observations, or at least a remarkable adaptability to them." On the whole, Hastie's claim on behalf of Kant is a just one.

Kant's discussion of the stellar Universe, at a time when stellar astronomy was in its infancy, is a very penetrating one. He notes first of all the importance of the Milky Way as the ground plan of the Universe. Here he gives full credit to Wright of Durham for his speculations as to stellar distribution. Accepting on the whole, the disc-theory of Wright—afterwards elaborated and then abandoned by Herschel—he attempted "to improve the thought which he thus indicated." After noting the aggregation of the bright stars to the galactic plane—the first time, says the late Mr. Gore, this fact was noted—Kant says "If we now imagine a plane down through the starry heavens and produced indefinitely and suppose that all the fixed stars and systems have a general relation in their places to this plane, so as to be found nearer to it than to other regions, then the eye which is situated in this plane when it looks out to the field of the stars, will perceive on the spherical concavity of the firmament the densest accumulation of stars in the direction of such a plane, under the form of a zone illuminated by varied light." Further on, Kant draws an analogy between the system of the stars and the planetary system. "If" he says "instead of the six planets with their ten companions we suppose there to be as many thousands of them; if the twenty-eight or thirty comets which have been observed be multiplied a thousand times and if we suppose these same bodies to be self-luminous, then the eye of the spectator looking at them from the earth would see before it just the very appearance of what is presented to it by the fixed stars of the Milky Way." All the suns, each in motion, constitute according in Kant, a system whose universal relative plane is the Milky Way. Considering the state of astronomy at the time when Kant wrote, his conception must be described as a marvelous effort of the imagination.

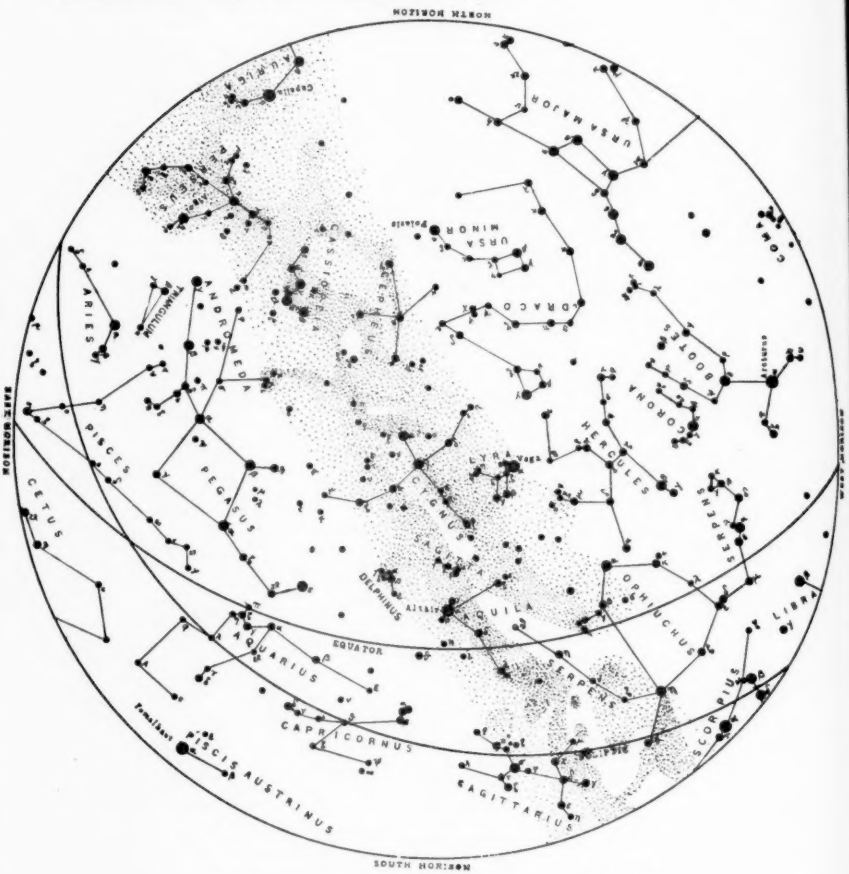
Kant also noted the fact that temporary stars generally appear in the regions of the heavens on or near the Milky Way. Towards the end of his essay he again discusses the question of the construction of the universe and in a footnote to an addition to his seventh chapter he throws out the idea that Sirius is the central star of the stellar system and he also suggests that the sun is nearest to that part of the galaxy which appears broadest. Underlying all of Kant's speculations, of course, is the fatal assumption, which Herschel afterwards made only to abandon it,—that of the equal scattering of the stars.

The sublimity of Kant's conception of the Cosmos is a notable feature of his investigation. Frankly his outlook is idealistic. He looks to God as the ultimate author of the universe, but in a very different way from the hard cold Deism or the sentimental semi-Deism of the eighteenth century. After a discussion of the views of the ancients and after commenting on a certain resemblance between his opinions and those of Lucretius, he says—"Matter is bound to certain laws and when it is freely abandoned to these laws, it must necessarily bring forth beautiful combinations. It has no freedom to deviate from this perfect plan..... There is a God just because nature even in chaos cannot proceed otherwise than regularly or according to order." Here we have emphasis laid on the rationality of the Universe—a strong argument for the religious view of the world to-day.

Further discussion on this line, however, would lead us from Kant as man of science, to Kant as philosopher; and as philosopher Kant's reputation is world-wide and enduring. Meanwhile, although we are compelled to admit Kant's great services to philosophy as the founder of a new school of thought, we cannot but regret that he abandoned science completely in later years. Had he continued his astronomical studies, the course of astronomy might have been different. In the course of two short essays, this great man—one of the greatest of the world's intellects—anticipated conclusions reached long after his day by modern men of science.

PLANET NOTES FOR SEPTEMBER AND OCTOBER 1913.

The sun will move from 8° north declination to 14° south declination during this period. It will cross the equator on September 23, the time of the autumnal equinox. It will move eastward from the constellation Leo into Virgo, and near the end of October will pass near the bright star Spica.



THE CONSTELLATIONS AT 9:00 P. M. SEPTEMBER 1, 1913.

The phases of the moon for these months are as follows :

First Quarter	Sept. 7 at	7 A.M.	C.S.T.
Full Moon	15 "	7 A.M.	"
Last Quarter	23 "	7 A.M.	"
New Moon	29 "	11 P.M.	"

First Quarter	Oct. 6 at	8 A.M.	C.S.T.
Full Moon	14 "	12 P.M.	"
Last Quarter	22 "	5 P.M.	"
New Moon	29 "	8 A.M.	"

Mercury will move eastward and pass the sun at Superior conjunction on September 15. Toward the close of October it will be approaching a period of greatest elongation east of the sun, and will be coming into a position of visibility in the southwest just after sunset.

Venus will be the bright morning star throughout this period. It will reach its position farthest from the sun in miles on October 14. It will rise about two hours ahead of the sun, and a few degrees south.

Mars will be getting into more favorable position for observation. On October 2 it will reach a position of quadrature, 90° west of the sun. It will then rise at midnight and be visible for the remainder of the night. It will be considerably north of the sun and for that reason will be favorably situated for northern observers. During this time it will be in the constellation Taurus, a few degrees east of Aldebaran.

Jupiter will be very favorably situated except for its position far south. On October 2 it will be in quadrature, 90° east of the sun. At this time it will set at midnight and may be observed during the early part of the evening.

Saturn also will be coming into better position. It will be in quadrature, 90° west of the sun, on September 11. It will then rise about midnight and be visible during the remainder of the night. It will also be quite far north and a few degrees west of Mars.

Uranus will be visible in the evening during this period. It will be in quadrature, 90° east of the sun, on October 27. It is quite far south.

Neptune will reach a position 90° west of the sun on October 21. It will then rise at midnight and be visible for the rest of the night. It will be near the boundary line between Gemini and Cancer.

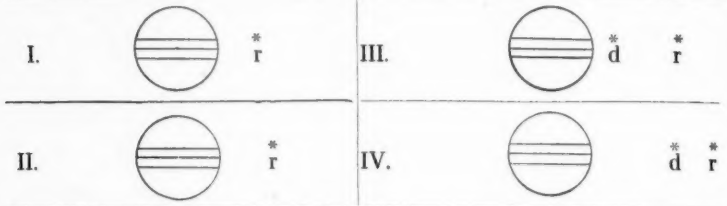
Occultations Visible at Washington.

Date 1908	Star's Name	Magnitude	IMMERSION. Washington M.T.		Angle from N.	EMERSION. Washington M.T.		Angle from N	Duration	
			h	m	°	h	m	°	h	m
Sept. 11	27 Capricorni	6.1	12	26	62	13	36	231	1	10
12	152 B Capricorni	6.5	7	22	52	8	46	250	1	24
14	317 B Aquarii	6.3	9	49	118	10	18	158	0	29
19	47 Arietis	5.8	8	30	30	9	15	278	0	45
20	η Tauri	3.0	7	46	58	8	33	63	0	47
20	27 Tauri	3.7	8	22	99	9	6	219	0	44
20	28 Tauri	5.2	8	22	81	9	13	237	0	51
24	4 Cancri	6.2	16	21	59	17	17	324	0	56
Oct. 5	W Sagit.(var)	4.3	8	33	127	9	19	211	0	46
7	ω Sagittarii	4.8	6	11	84	7	37	233	1	26
11	*h* Aquarii	5.4	7	0	41	8	22	243	1	22
11	ϕ Aquarii	4.4	14	40	87	15	34	209	0	54
16	ϵ Arietis(mean)	4.6	17	34	31	18	24	299	0	50
17	16 Tauri	5.4	13	0	90	14	20	221	1	20
17	*q* Tauri	4.3	13	22	62	14	51	251	1	29
17	20 Tauri	4.1	13	45	98	15	2	218	1	17
17	21 Tauri	5.8	13	54	59	15	22	258	1	28
17	22 Tauri	6.5	13	57	68	15	27	250	1	30
20	49 Aurigae	5.1	11	56	74	13	4	275	1	8
20	54 Aurigae	5.8	14	35	20	15	2	341	0	27
21	C Geminorum	5.5	16	59	96	18	22	302	1	23
25	80 Leonis	6.4	17	10	121	18	16	308	1	6

Satellites of Jupiter, September 1913.

WASHINGTON MEAN TIME.

Phases of the Eclipses of the Satellites for an Inverting Telescope.



Configurations at $9^h\ 0^m$ for an Inverting Telescope.

Day	West	East
1	·1 ·3 ○ ·4 ·2	
2	·3 ·2 ○ ·1 ·4	
3	·3 ·1 ·2 ○ ·4	
4	·3 ○ ·1 ·2 ·4	
5	·1 2· ○ ·3 ·4	
6	○1· ·2 ○ ·3 ·4	
7	○ ·2 ·3 ·4 ·1●	
8	·1 ○ ·3 ·2 ·4	
9	·3 ·2 ·4 ○ ·1	
10	·3 4· ·1 ·2 ○	
11	·4 ·3 ○ ·1 ·2	
12	○2. ·4 ·1 ○ ·3	
13	·4 ·2 ○ 1· ·3	
14	·4 ○ ·2 ·3 ·1●	
15	·4 ·1 ○ 3· ·2	
16	·4 3· ·2 ○ ·1	
17	·3 ·2 ·1 ·4 ○2·	
18	·3 ○ ·1 ·4 ·2	
19	·1 ○·2 ·4 ·3●	
20	·2 ○ ·1 ·3 ·4	
21	·1 ○ ·3 4. ·2●	
22	○1· ○ ·3 ·2 ·4	
23	·3 ·2 ○ ·1 .4	
24	·3 ·21· ○ ·4	
25	·3 ○ ·4 ·1 ·2	
26	·1 ·4 ○ ·2 ·3●	
27	·4 ·2 ○ ·1 ·3	
28	·4 ·1 ○ ·3 ·2●	
29	○1· ·4 ○ ·3 ·2	
30	·4 ·3 ·2 ○ ·1●	

Phenomena of Jupiter's Satellites.

CENTRAL STANDARD TIME.

1913	h	m		1913	h	m	
Sept. 1	7	47	III Tr. Eg.	Sept. 28	7	14	II Oc. Dis.
	8	6	IV Ec. Re.	29	7	53	I Tr. In.
	9	9	III Sh. In.		9	12	I Sh. In.
3	10	19	II Oc. Dis.	30	7	42	II Sh. Eg.
5	7	37	II Sh. In.		8	44	I Ec. Re.
	8	5	II Tr. Eg.	Oct. 1	5	59	I Sh. Eg.
	10	28	II Sh. Eg.	4	7	59	IV Oc. Re.
	19	33	I Oc. Dis.	7	5	11	III Sh. In.
6	7	44	I Tr. In.		7	4	I Oc. Dis.
	8	57	I Sh. In.		7	16	II Sh. In.
	10	2	I Tr. Eg.		7	31	II Tr. Eg.
7	8	30	I Ec. Re.		8	39	III Sh. Eg.
8	8	14	III Tr. In.	8	5	36	I Sh. In.
12	6	40	III Ec. Re.		6	36	I Tr. Eg.
	7	44	II Tr. In.		7	55	I Sh. Eg.
	10	12	II Sh. In.	13	5	28	IV Sh. Eg.
13	9	36	I Tr. In.	14	7	18	II Tr. In.
14	6	53	I Oc. Dis.		7	22	III Tr. Eg.
	7	28	II Ec. Re.	15	6	15	I Tr. In.
15	6	32	I Tr. Eg.		7	32	I Sh. In.
	7	39	I Sh. Eg.	16	7	3	I Ec. Re.
19	7	25	III Ec. Dis.		7	21	II Ec. Re.
21	8	46	I Oc. Dis.	21	8	11	III Tr. In.
22	5	58	I Tr. In.	23	5	27	I Oc. Dis.
	7	15	I Sh. In.	24	5	1	I Tr. Eg.
	8	16	I Tr. Eg.		6	15	I Sh. Eg.
	9	35	I Sh. Eg.	25	6	45	III Ec. Re.
23	6	49	I Ec. Re.	30	7	22	II Oc. Dis.
26	6	5	III Oc. Dis.		7	25	I Oc. Dis.
	7	38	IV Sh. In.	31	4	41	I Tr. In.
	9	23	III Oc. Dis.		5	52	I Sh. In.
					6	59	I Tr. Eg.

Note:—In., denotes ingress; Eg., egress; Dis., disappearance; Re., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh.. transit of the shadow.

VARIABLE STARS.

Variable Star Y Ophiuchi.—In the *Bulletin Astronomique* for June 1913 Mr. M. Luizet gives a light curve constructed from 519 observations made by him during the years 1898-1912. He finds 65 maxima and 54 minima represented by his observations. The star is a Cepheid, with an irregular light curve, there being slight indications of a secondary maximum a couple of days preceding the minimum. The Period is $17^d\ 2^h\ 53^m\ 48^s$, the rise from minimum to maximum requiring only $6^d\ 7^h$. The magnitudes at maximum and minimum are 5.86 and 6.65 respectively.

Minimum of Mira, *o* Ceti.—In *A. N.* 4662 Mr. A.A. Nijland of Utrecht, gives observations of Mira from July 16, 1912, to March 5, 1913. These show a steady decline of the star until December, then a more rapid rise. The minimum occurred about December 10, when the magnitude was about 9.8.

Approximate Magnitudes of Variable Stars on July 1, 1913.

[Communicated by the Director of Harvard College Observatory, Cambridge, Mass.]

Name.	R. A. 1900. h m	Decl. 1900. ° ′	Magn.	Name.	R.A. 1900. h m	Decl. 1900. ° ′	Magn.
X Androm.	0 10.8	+46 27	10.5 *i*	RU Herculis	16 6.0	+25 20	12.8
T Androm.	17.2	+26 26	8.3 *i*	W Cor. Bor.	11.8	+38 3	11.0
T Cassiop.	17.8	+55 14	10.0 *i*	U Herculis	21.4	+19 7	10.8
R Androm.	18.8	+38 1	10.5*d*	W Herculis	31.7	+37 32	10.8
Y Cephei	31.3	+79 48	13.3*d*	R Urs. Min.	31.3	+72 28	9.3
U Cassiop.	40.8	+47 43	8.2 *i*	R Draconis	32.4	+66 58	8.5 *i*
RW Androm.	41.9	+32 8	11.8*d*	S Herculis	47.4	+15 7	10.5
RV Cassiop.	47.1	+46 53	<13.	RR Scorpii	50.2	−30 25	8.8
W Cassiop.	49.0	+58 1	11.4*d*	R Ophiuchi	17 2.0	−15 58	<11.
U Androm.	1 9.8	+40 11	<13.	Z Ophiuchi	14.5	+1 37	7.8
– Androm.	10.4	+41 12	<13.	V Draconis	56.3	+54 53	11.1 *i*
S Cassiop.	12.3	+72 5	9.2 *i*	T Herculis	18 5.3	+31 0	10.2*d*
RZ Persei	23.6	+50 20	9.8	W Draconis	5.4	+65 56	14.1
RU Androm.	32.8	+38 10	<12.	X Draconis	6.8	+66 8	11.8
Y Androm.	33.7	+38 50	10.6*d*	W Lyrae	11.5	+36 38	7.8
W Androm.	2 11.2	+43 50	<12.	SV Draconis	31.2	+49 18	11.2
Z Cephei	12.8	+81 13	<14.	RY Lyrae	41.2	+34 34	10.6*d*
RR Persei	21.7	+50 49	9.5	Z Lyrae	56.0	+34 49	13.9
RR Cephei	29.4	+80 42	<13.	V Lyrae	19 5.2	+29 30	13.3
V Camelop.	5 49.4	+74 30	<11.	S Lyrae	9.1	+25 50	<14.
U Lyncis	6 31.8	+59 57	12.8*d*	U Draconis	9.9	+67 7	9.4
R Cancri	8 11.0	+12 2	8.2	TZ Cygni	13.4	+50 0	10.2
Y Draconis	9 31.1	+78 18	<14.	U Lyrae	16.6	+37 42	11.0
R Leonis	42.2	+11 54	9.0	R Cygni	34.1	+49 58	11.2*d*
R Urs. Maj.	10 37.6	+69 18	8.0	RT Cygni	40.8	+48 32	11.2
R Com. Ber.	11 59.1	+19 20	9.6	TU Cygni	43.3	+48 49	9.3
SS Virginis	12 20.1	+ 1 19	7.8	S Aquilae	20 7.0	+15 19	9.8
T Can. Ven.	25.2	+32 3	10.2	R Sagittae	9.5	+16 25	9.0
T Urs. Maj.	31.8	+60 2	8.9 *i*	RS Cygni	9.8	+38 28	8.5
R Virginis	33.4	+ 7 32	11.1*d*	R Delphini	10.1	+ 8 47	<11.
RS Urs. Maj.	34.4	+59 2	<13.	V Sagittae	15.8	+20 47	11.2
S Urs. Maj.	39.6	+61 38	8.7 *i*	U Cygni	16.5	+47 35	7.3
U Virginis	46.0	+ 6 6	8.6*d*	SZ Cygni	29.6	+46 16	8.8
R Hydrae	13 24.2	−22 46	8.9*d*	ST Cygni	29.9	+54 38	14.0
T Urs. Min.	32.6	+73 56	13.8	V Cygni	38.1	+47 47	9.5
R Can. Ven.	44.6	+40 2	8.6*d*	T Aquarii	44.7	− 5 31	8.7 *i*
U Urs. Min.	14 15.1	+67 15	10.1*d*	R Vulpeculae	59.9	+23 26	11.0
S Bootis	19.5	+54 16	8.1	RS Capric.	21 1.7	−16 49	8.2
RS Virginis	22.3	+ 5 8	8.0	TW Cygni	1.8	+29 0	12.4
V Bootis	25.7	+39 18	8.4 *i*	X Cephei	3.6	+82 40	13.9
R Camelop.	25.1	+84 17	8.5*d*	R Equulei	8.4	+12 23	13.2
R Bootis	32.8	+27 10	8.0	T Cephei	8.2	+68 5	7.7
Y Librae	15 6.4	− 5 38	<11.	W Cygni	32.2	+44 56	6.0
S Librae	15.6	−20 2	8.9	S Cephei	36.5	+78 10	8.5
S Cor. Bor.	17.3	+31 44	11.0	RV Cygni	39.1	+37 34	7.7
RS Librae	18.5	−22 33	9.4	Y Pegasi	22 6.8	+13 52	13.
RU Librae	27.7	−14 59	12.5	RS Pegasi	7.4	+14 4	12.7
S Urs. Min.	33.4	+78 58	9.9	V Cassiop.	23 7.4	+59 8	11.0*d*
X Cor. Bor.	45.2	+36 35	12.8	ST Androm.	33.8	+35 13	9.5
R Serpentis	46.1	+15 26	8.0	Z Cassiop.	39.7	+56 2	13.
V Cor. Bor.	46.0	+39 52	10.6*d*	R Cassiop.	53.3	+50 50	8.5 *i*
RZ Scorpii	58.6	−23 50	9.0*d*	Y Cassiop.	58.2	+55 7	12.
U Serpentis	16 2.5	+10 12	9.0	SV Androm.	59.2	+39 33	13.

The letter *i* denotes that the light is increasing; the letter *d*, that the light is decreasing; the sign < that the variable is fainter than the appended magnitude.

The above magnitudes have been compiled at the Harvard College Observatory from observations made by the following observers:—H. C. Bancroft, Jr., T. C. H. Bouton, A. P. C. Craig, T. Dunham, Jr., E. L. Forsyth, N. V. Ginori, E. Gray, F. E. Hathorn, S. C. Hunter, M. W. Jacobs, Jr., J. B. Lacchini, F. C. Leonard, C. Y. McAteer, O. Mach, W. T. Olcott, H. M. Swartz, D. Todd, and H. W. Vrooman.

Minima of Variable Stars of Short Period.

[Calculated by Myrtle L. Richmond, E. R. Peterson and S. N. Stearns at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain eastern Standard time subtract 5h; Central Standard 6h, etc.

Star	R. A. 1900		Decl. 1900		Magnitude	Approx. Period		Greenwich mean times of minima in 1913							
								September				October			
	h	m	°	′		d	h	d	h	d	h	d	h	d	h
SY Androm.	0	08.0	+43	09	9.5—13.0	34	21.9	19	17			24	15		
RT Sculptor	0	31.5	−26	13	9.6—10.5	0	12.3	10	1;	25	10;	10	18;	26	2
UU Androm.		38.5	+30	24	10.7—11.9	1	11.7	9	9;	24	6;	9	3;	24	10
U Cephei	0	53.4	+81	20	7.0— 9.0	2	11.8	14	16;	29	15;	14	14;	29	12
Z Persei	2	33.7	+41	46	9.4—12	3	01.4	8	19;	21	0;	9	8;	21	14
RY Persei		39.0	+47	43	8.0—10.3	6	20.7	10	20;	24	13;	8	7;	22	0
RZ Cassiop.	2	39.9	+69	13	6.4— 7.8	1	04.7	8	13;	22	21;	13	9;	27	18
ST Persei		53.7	+38	47	8.5—10.5	2	15.6	10	0;	25	21;	11	19;	27	16
RX Cassiop.	2	58.8	+67	11	8.6— 9.1	32	07.6	20	18			23	2		
Algol	3	01.7	+40	34	2.3— 3.5	2	20.8	12	3;	23	14;	9	19;	21	6
RT Persei		16.7	+46	12	9.5—11.5	0	20.4	12	11;	26	1;	9	15;	23	5
λ Tauri		55.1	+12	12	3.4— 4.5	3	22.9	9	11;	25	6;	11	1;	26	21
RW Tauri	3	57.8	+27	51	7.1—<11	2	18.5	6	3;	22	18;	9	8;	25	23
RV Persei	4	04.2	+33	59	9.5—11.0	1	23.4	7	21;	19	17;	7	12;	25	6
RW Persei	4	13.3	+42	04	8.8—11.0	13	04.8	7	2;	20	7;	16	17;	29	22
SZ Tauri		31.4	+18	20	7.2— 7.7	3	03.6	10	7;	22	21;	11	19;	24	9
RS Cephei	4	48.6	+80	06	9.5—12.0	12	10.1	10	22;	23	8;	18	4;	30	14
TT Aurigae	5	02.8	+39	27	7.8— 8.7	0	16.0	7	19;	21	3;	11	3;	24	11
RY Aurigae		11.5	+38	13	10.7—11.7	2	17.5	9	13;	20	11;	6	20;	23	4
RZ Aurigae		42.9	+31	40	10.6—13.3	3	00.3	10	9;	22	10;	10	12;	22	13
SV Tauri		45.8	+28	05	9.4—11.0	2	04.0	11	12;	24	12;	7	12;	20	12
SV Gemin.	5	54.6	+24	28	9.8—<11	4	00.2	13	20;	29	21;	15	21;	31	22
RW Gemin.	5	55.4	+23	08	9.5—11.0	2	20.8	8	2;	19	14;	6	18;	23	23
U Columbae	6	11.2	−33	03	9.4—10.2	2	19.2	8	0;	24	19;	11	15;	22	19
SX Gemin.		22.0	+20	37	10.8—11.5	1	08.8	9	22;	20	21;	7	6;	23	16
RW Monoc.	6	49.4	−	7 28	9.8—10.5	0	21.5	10	7;	25	13;	10	19;	26	1
RX Gemin.		43.6	+33	21	8.8— 9.6	12	05.0	10	0;	22	5;	16	15;	28	20
RU Monoc.		29.3	+	8 54	9.0—10.8	1	21.7	13	7;	27	15;	11	23;	26	7
R Can. Maj.	7	14.9	−16	12	5.8— 6.4	1	03.3	7	21;	24	22;	11	23;	23	8
RY Gemin.		21.7	+15	52	8.9—<10	9	07.2	3	22;	22	13;	11	3;	29	18
Y Camelop.		27.6	+76	17	9.5—12	3	07.3	10	19;	24	1;	13	21;	27	2
RR Puppis		43.5	−41	08	9.5—	6	10.3	13	12;	26	9;	9	5;	22	2
V Puppis	7	55.4	−48	58	4.1— 5.8	1	10.9	13	15;	28	4;	12	17;	27	6
X Carinae	8	29.1	−58	53	7.9— 8.7	0	13.0	6	12;	22	17;	8	23;	25	5
S Cancri		38.2	+19	24	8.2—10	9	11.6	6	5;	25	5;	4	16;	23	16
S Antliae		27.9	−28	11	6.7— 7.8	0	07.8	8	6;	21	5;	10	16;	23	15
S Velorum		28.5	−44	46	7.8— 9.1	5	22.4	12	4;	24	1;	11	20;	23	17
Y Leonis	9	31.1	+26	41	9.3—11.2	1	16.5	7	21;	24	18;	11	15;	28	12
RR Velorum	10	17.8	−41	36	10.0—10.9	1	20.5	8	0;	26	13;	15	2;	24	8
SS Carinae	10	54.2	−61	23	12.2—12.8	3	07.0	5	0;	18	5;	8	1;	21	6
ST Urs. Maj.	11	22.4	+45	44	6.7— 7.2	8	19.2	13	5;	30	19;	18	10;	27	5
RW Urs. Maj.		35.4	+51	34	9.3—10.3	7	07.9	9	15;	24	7;	8	23;	23	15
Z Draconis	11	40.6	+72	48	9.5—12.5	1	08.6	7	21;	21	11;	11	20;	25	9
SS Centauri	13	07.2	−63	37	8.8—10.4	2	11.5	10	19;	25	16;	10	12;	25	9
δ Librae	14	55·6	−	8 07	5. — 6.7	2	07.9	13	14;	27	13;	11	13;	25	12
U Coronae	15	14.1	+32	01	7.6— 8.7	3	10.9	9	17;	23	12;	14	5;	28	0
TW Draconis		32.4	+64	14	7.0— 8.9	2	19.4	6	20;	23	17;	10	13;	27	9
114.1908 Librae	15	43.4	−64	14	9.3—11.5	0	18.4	10	22;	26	6;	11	13;	26	21
SW Ophiuchi	16	11.1	−	6 44	9.2—10.0	2	10.7	9	6;	23	22;	8	14;	23	6
SX Ophiuchi		12.6	−	6 25	10.5—11.2	2	01.5	10	2;	26	14;	13	2;	29	15
R Arae		31.1	−56	48	6.7— 8.	4	10.2	5	20;	23	12;	11	5;	28	22
TT Herculis	16	49.9	+17	00	8.9— 9.3	20	18.1	10	2;	30	20;	11	22;	21	14

Minima of Variable Stars of Short Period.—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean time of minima in 1913							
					September				October			
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	8 10;	22 0;	12 10;	26 0				
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	13 10;	30 5;	17 0;	25 9				
u Herculis	13.6	+33 12	5.1— 5.6	2 01.2	12 3;	24 11;	12 22;	25 5				
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	8 23;	23 9;	15 0;	29 10				
RV Ophiuchi	29.8	+ 7 19	9. —<11	3 16.5	15 11;	30 5;	14 22;	29 17				
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	14 1;	30 10;	16 19;	24 23				
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	13 17;	28 19;	13 21;	28 23				
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	10 19;	26 18;	12 17;	28 16				
WX Sagittae	53.6	−17 24	9.2—10.8	2 36.6	9 0;	21 19;	10 23;	23 18				
WY Sagittae	17 54.9	−23 1	9.5—10.6	4 16.0	7 5;	21 5;	9 21;	23 22				
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	11 6;	21 14;	7 2;	22 14				
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 10.0	12 14;	27 2;	11 14;	26 2				
V Serpentis	18 11.1	−15 34	9.5—11.1	3 10.9	13 16;	27 12;	11 7;	25 3				
RZ Scuti	18 21.1	− 9 15	7.4— 8.3	15 3.2	6 17;	21 20;	6 23;	22 3				
RZ Draconis	21.8	+ 58 50	9.5—10.2	0 13.2	10 2;	21 3;	7 15;	24 4				
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	6 21;	24 16;	12 10;	30 5				
SX Sagittarii	39.7	−30 36	8.6— 9.4	2 01.8	10 3;	22 14;	11 7;	23 18				
RR Draconis	18 40.8	+62 34	8.5—<12	2 19.9	13 19;	30 19;	17 18;	26 6				
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	10 11;	23 18;	13 17;	27 0				
β Lyrae	46.4	+33 15	3.4— 4.5	12 21.8	6 22;	19 19;	15 15;	28 13				
U Scuti	18 48.9	−12 44	9.0— 9.8	0 22.9	4 21;	23 23;	13 2;	22 15				
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.5	15 0;	30 4;	15 7;	30 11				
RV Lyrae	12.5	+32 15	11. —13	3 14.4	9 5;	23 14;	15 4;	29 14				
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	4 8;	22 6;	10 4;	28 3				
U Sagittae	14.4	+19 26	6.7— 9.0	3 09.1	13 5;	26 18;	10 6;	23 19				
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	14 20;	29 14;	14 7;	29 1				
TT Lyrae	24.3	+41 30	9.0—<11	5 05.8	10 12;	20 23;	6 17;	22 10				
120.1907 Draconis	19 26.2	+68 44	9.3—10	1 15.1	8 13;	21 14;	11 4;	24 6				
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	9 10;	21 10;	9 11;	21 11				
WW Cygni	20 00.6	+41 18	9.5—12.5	3 07.6	9 8;	22 14;	12 12;	25 19				
SW Cygni	03.8	+46 01	9. —12	4 13.8	7 11;	25 18;	14 1;	23 5				
VW Cygni	11.4	+34 12	9.5—11.5	8 10.3	13 8;	30 5;	17 2;	25 12				
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	12 14;	26 4;	9 18;	23 7				
UW Cygni	19.6	+42 55	10.5—13	3 10.8	13 21;	27 16;	11 11;	25 6				
V Vulpec.	32.3	+26 15	8.0—9.0	37 19.0		28 6						
W Delphini	33.1	+17 56	9.5—11.5	4 19.4	8 13;	27 19;	17 0;	26 15				
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	12 3;	30 12;	9 17;	28 3				
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	14 23;	29 23;	14 22;	29 21				
WZ Cygni	49.3	+38 27	9.8—10.8	0 14.0	10 9;	22 2;	9 15;	21 7				
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	8 15;	23 18;	8 22;	29 3				
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	14 7;	29 1;	13 19;	28 14				
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	6 8;	25 17;	15 2;	24 19				
UZ Cygni	55.2	+43 52	9. —11.5	31 07.3	21 9		22 17					
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	9 11;	24 17;	9 22;	30 5				
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	10 0;	25 13;	11 3;	26 16				
X Lacertae	22 45.0	+55 54	8.2— 8.6	5 10.6	8 17;	25 1;	11 9;	22 6				
TT Androm.	23 08.7	+45 36	10.5—11.3	2 18.3	15 21;	24 4;	10 18;	27 8				
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	12 17;	27 18;	12 20;	27 21				
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	11 12;	28 0;	14 12;	30 23				

Minimum of Algol.—In *A.N.* 4657 Mr. K. Graff gives observations of minima of Algol on January 10 and 30, 1913, which indicate that our ephemerides for that star require a correction of about $-1^h\ 43^m$.

Maxima of Variable Stars of Short Period.

[Calculated by May E. Abbott, Hazel H. Barnard, Helen A. Orr, and Myrtle L. Richmond at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5^h; Central standard time 6^h etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1913							
					September				October			
	h m	° ′		d h	d h		d h		d h		d h	
SX Cassiop.	0 05.5	+54 20	8.6— 9.4	36 13.7			21	20			28	9
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	8	21;	25	3;	11	10;	27	17
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	13	8;	28	20;	14	7;	29	19
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	11	12;	26	7;	11	2;	25	22
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	8	20;	24	17;	10	14;	26	11
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	16	14;	24	9;	10	0;	25	14
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	9	19;	24	8;	8	22;	23	12
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	6	0;	22	0;	8	0;	24	0
SX Persei	4 10.2	+41 27	10.4—11.2	4 06.9	5	7;	22	11;	9	15;	26	19
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	12	0;	23	3;	15	10;	26	13
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0	2	0;	25	6;	18	12;	30	3
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	9	15;	24	23;	10	6;	25	14
SY Aurigae	05.5	+42 42	8.4— 9.5	10 03.3	1	21;	22	3;	12	10;	22	13
Y Aurigae	21.6	+42 21	8.6— 9.6	3 20.6	9	13;	25	0;	10	11;	25	21
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	10	8;	21	9;	7	23;	24	13
RS Orionis	6 16.5	+14 43	7.8— 8.5	7 13.4	8	16;	23	19;	8	22;	24	1
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3			22	8;			19	8
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	11	14;	26	0;	10	10;	24	19
W Gemin.	29.2	+15 24	6.8— 7.6	7 22.0	15	15;	23	13;	9	9;	25	5
ζ Gemin.	6 58.2	+20 43	3.7— 4.5	10 03.7	11	18;	21	21;	12	5;	22	8
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5	14	4;			6	10;	28	17
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	14	9;	30	7;	16	4;	24	3
V Carinae	8 26.7	−59 47	7.2— 8.0	6 16.7	10	8;	23	17;	13	19;	27	5
T Velorum	8 34.4	−47 01	7.5— 8.5	4 15.3	3	13;	21	27;	10	16;	29	6
W Carinae	9 19.2	−55 32	7.5— 8.5	4 08.9	6	14;	24	1;	11	13;	29	1
W Ursae Maj.	9 36.7	+56 24	7.9— 8.6	0 04.0	8	10;	21	19;	11	19;	25	3
RR Leonis	10 02.1	+24 03	9.1—10.1	0 10.9	11	14;	25	3;	8	18;	22	7
SW Draconis	11 32.2	+67 53	8.9— 9.6	0 16.0	13	1;	26	6;	9	11;	22	16
S Muscae	12 07.4	−69 36	6.5— 7.3	9 15.8	10	20;	30	4;	19	11;	29	3
SU Draconis	12.8	+70 04	8.8— 9.6	0 13.7	13	15;	29	14;	15	13;	31	11
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	12	15;	26	2;	9	13;	23	0
R Crucis	18.1	−61 04	6.8— 8.0	5 19.8	8	7;	19	22;	7	10;	24	21
S Crucis	48.4	−57 53	6.6— 7.8	4 16.6	5	23;	20	1;	4	2;	22	21
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	10	8;	25	8;	10	8;	25	8
W Virginis	13 20.9	− 2 52	8·7—10.4	17 06.5	2	22;	20	4;	7	11;	24	17
RV Ursae Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	12	21;	26	22;	10	23;	25	0
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	12	8;	28	18;	14	5;	22	10
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	8	12;	25	0;	11	11;	22	11
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	13	9;	28	11;	13	13;	28	15
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	11	21;	26	16;	11	12;	26	8
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	6	13;	20	2;	10	11;	24	0
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	7	16;	20	7;	9	7;	21	22
S Normae	16 10.6	−57 39	6.5— 7.4	9 18.1	1	23;	21	12;	11	0;	30	12
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	9	15;	27	8;	18	11;	27	8
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	10	7;	22	10;	10	14;	22	17
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	8	9;	22	9;	13	10;	27	11
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9	17	4;			4	7;	21	9
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	9	20;	25	1;	10	5;	25	10
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	7	18;	25	2;	12	9;	23	22
U Sagittarii	18 26.0	−19 12	6.5— 7.3	6 17.9	9	15;	23	3;	13	8;	26	20
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3	10	12;	20	20;	11	13;	21	22
Y Lyrae	34.2	+43 52	11.3—12.3	0 12.1	8	1;	20	3;	8	5;	20	7

Maxima of Variable Stars of Short Period.—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1913. September				October			
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
RZ Lyrae	18 39.9	+32 42	9.9—11.2	0 12.3	9 21;	22 3;	10 13;	22 20				
RT Scuti	44.1	−10 30	9.1— 9.7	0 11.9	7 23;	19 20;	7 16;	25 12				
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	9 16;	27 20;	16 1;	25 3				
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	13 20;	27 21;	11 22;	25 23				
XZ Cygni	30.4	+56 10	8.7— 9.3	0 11.2	10 12;	24 12;	8 12;	22 11				
U Vulpec.	32.2	+20 07	6.9— 7.6	7 23.5	14 17;	30 16;	16 15;	24 14				
SU Cygni	40.8	+29 01	6.6— 7.4	3 20.3	14 2;	29 11;	14 20;	30 6				
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	11 22;	26 6;	10 15;	24 23				
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	13 2;	29 21;	16 15;	25 0				
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	12 7;	24 22;	7 13;	20 5				
XX Cygni	20 01.3	+58 40	10.5—11.5	0 03.2	14 3;	27 15;	11 2;	24 14				
X Cygni	39.5	+35 14	6.0— 7.0	16 09.3	11 5;	27 14;	13 23;	30 9				
T Vulpec.	20 47.2	+27 52	5.5— 6.5	4 10.5	9 6;	22 13;	5 21;	23 15				
WY Cygni	20 52.3	+30 03	9.5—10.3	0 13.5	13 23;	27 10;	10 21;	24 8				
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	8 12;	21 23;	12 2;	25 12				
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	6 14;	21 7;	6 1;	20 18				
VY Cygni	21 00.4	+39 34	8.9— 9.5	7 20.6	14 12;	30 5;	15 22;	31 16				
VZ Cygni	21 47.7	+42 40	8.4— 9.2	4 20.7	7 22;	22 13;	7 3;	26 14				
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	9 16;	27 0;	14 7;	31 14				
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	8 18;	24 21;	10 23;	21 17				
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	9 10;	20 7;	12 1;	22 22				
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	8 5;	21 1;	10 7;	23 3				
V Lacertae	22 44.5	+55 48	8.2— 8.9	4 23.6	9 3;	24 1;	9 0;	23 23				
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	6 20;	23 4;	9 12;	25 19				
RS Cassiop.	32.6	+61 52	9.1—10.0	6 07.1	10 7;	22 21;	11 18;	24 9				
RY Cassiop.	47.2	+58 11	9.2—10.0	12 03.4	2 20;	27 3;	9 6;	21 10				
U Pegasi	23 52.9	+15 24	9.3— 9.9	0 04.5	15 9;	30 9;	15 9;	30 9				

Orbit of U Sagittae.—In Publications of the Allegheny Observatory Vol. III, No. 2, Miss Mary Fowler gives a determination of the orbit of the spectroscopic binary star U Sagittae, from 85 spectrograms taken with the Mellon spectrograph during the years 1907, 1909, 1910 and 1911. The variable character of this star, of which the position is $\alpha = 19^h\ 14^m$, $\delta = +19°\ 26'$, was discovered by Schwab in 1901. He found it to be an Algol variable, ranging from 6.9 to 9.0 magnitude. By means of the photographs taken at Harvard College Observatory, observations of the star were extended as far back as 1887, so that the period is well determined. The most recent and best formula for the light variation is that by Graff (Mitteilungen der Hamburger Sternwarte, No. 11, page 51):

$$\begin{aligned}\text{Minimum} &= 1905\ \text{Oct. } 11,\ 9^h\ 55^m.1 + 3^d\ 9^h\ 8^m\ 4^s.1\ E \\ &= \text{J.D. } 2417130.4133 + 3^d.380603\ E\end{aligned}$$

The following are the definitive elements of the orbit as determined by Miss Fowler:

$P = 3.380603$ days
$\mu = 106°.4899$
$e = 0.035 \pm 0.012$
$T = 1909$ May 1.183, G.M.T. ± 0.034 days
$= \text{J.D. } 2{,}418{,}428{,}183$
$\omega = 44°.14 \pm 30°.9$
$K = 66.45$ km. ± 1.28 km.
$\gamma = -19.13$ km.
$a \sin i = 3{,}090{,}000$ km.

Algol-Type Variable Z Orionis.—In *A.N.* 4662 Mr. Luizet gives new elements and light curve of the Algol-type star Z Orionis (BD+13° 1034 α 5^h 47^m 37^s.7 δ + 13° 39′.4). The period is 5^d 4^h 52^m 49^s.5 and the elements are

Minimum = J.D. 2418270.392 Gr. m.t. + 5^d.20335 E.

There is a slight secondary minimum nearly midway between the principal minima. The normal magnitude of the star is about 9.6; at the secondary minimum it is 9.7 and at the principal minimum 10.5.

Mr. Luizet used the following comparison stars:

		L	L′
a =	BD. + 13° 1039	12^{deg}.0	9^m.4
b =	+ 13 1029	7 .1	9 .8
d =	+ 13 1040	2 .3	10 .2
c =	+ 13 1038	0 .0	10 .4

Variable Star RS Orionis.—In *A.N.* 4662 Mr. M. Luizet gives elements and a light curve of the variable star RS Orionis (BD + 14° 1259, α 6^h 13^m 57^s, δ + 14° 44′.5), which was announced by Professor Ceraski in *A.N.* 4252. The period derived is 7^d 13^h 35^m.76 and the elements are

Maximum = J.D. 2418274.65 Gr. m. t. + 7^d.5665 E
Minimum = J.D. 2418271.76 " "

The light curve is of the Cepheid type with a secondary maximum just preceding the principal minimum. The range of brightness is between magnitudes 8.2 and 8.9.

M. Luizet's light scale for this star is indicated by the following comparison stars:

A =	BD. + 14° 1254	15^{deg}.3	7^m.7
b =	+ 14 1260	6 .8	8 .4
a =	+ 14 1267	0 .0	9 .0

Observations of Nova (2) Geminorum.—The following observations of the Nova (2) Geminorum complete those made during the present apparition of the star in the evening sky. After June 10, it was neither profitable nor advisable to follow the Nova further, due to its close proximity to the Sun and consequent low position in the strong twilight. Telescope, 4-inch equatorial refractor.

OBSERVATIONS OF NOVA (2) GEMINORUM
1913, May 12–June 10.

Date	Mag.	Color	Comparison Stars
May 12	8.7	Light bluish green	BD.+32° 1434 and 1442
May 15	8.7	Light bluish green	BD.+32° 1434 and 1442
May 17	8.9	Light bluish green	BD.+32° 1434 and 1442
May 31	8.9	Light bluish green	BD.+32° 1434 and 1442
June 1	8.9	Light bluish green	BD.+32° 1434 and 1442
June 2	9.0	Light bluish green	BD.+32° 1434 and 1442
June 3	8.9	Light bluish green	BD.+32° 1434 and 1442
June 4	8.9	Light bluish green	BD.+32° 1434 and 1442
June 7	8.9	Light bluish green	BD.+32° 1434 and 1442
June 8	9.0	Light bluish green	BD.+32° 1434 and 1442
June 9	8.9	Light bluish green	BD.+32° 1434 and 1442
June 10	9.0	Light bluish green	BD.+32° 1434 and 1442

Between the dates May 17 and 31 atmospheric conditions were in the main unfavorable, so no observations were obtained throughout that time.

It is obvious from the table of observations that during this month the Nova has manifested little activity. On the whole, however, it seems to have declined

about 0.3 of a magnitude, as in the case of the preceding set of observations*, having passed from magnitude 8.7 on May 12 to magnitude 9.0 on June 10. Its color has remained absolutely the same, having been light bluish green throughout this entire period.

GENERAL CONCLUSION TO OBSERVATIONS MADE

1912, Aug. 31-1913, June 10.

Comparing all my observations of the Nova made during the late visibility of the star, *i.e.*, from its reappearance in the morning sky to its disappearance in the evening, (1912, Aug. 31-1913, June 10), we find that from first to last, disregarding its fluctuations in brightness which have occurred from time to time in the course of the observations, it has slowly faded from about magnitude 7.5, (its maximum brightness for the period), to magnitude 9.0, (its minimum faintness for the same), a drop of approximately 1.5 magnitude. Its decline has been very slow and gradual and has frequently been intermitted by times of considerable variation and oscillation both in magnitude and color, as, *e.g.*, that between January 8 and February 11†, when the star was unusually active. Speaking generally, its color has remained to a great extent unchanged, having shifted merely from a light greenish blue to a light bluish green tinge. On the whole, however, this has perhaps accompanied to a degree the shifts in magnitude of the star as relates to intensity and as was so strikingly evident last year, the first of the Nova's apparition.

Since the discovery of the Nova on 1912, March 12, when it blazed out in the constellation Gemini as a star of about the 4th magnitude, and reached its maximum brilliancy, magnitude 3.5, two days later, on March 14, it has waned altogether 5.5 magnitudes in a period of one year and three months, lacking two days. Yet this decline has been very irregular and has been attended by the most wonderful and complex fluctuations both in light and in color; however, it would seem, in view of our accumulated knowledge and data, that the star is now slowly fading out, but what will ultimately become of it is as yet largely a matter for speculation, except, possibly, that which might be inferred from an analogy of its behavior with that of other novæ.

We cannot help wondering what this remarkable sun will eventually develop into and whether it will finally vanish from human sight and thereby pass beyond our sphere of investigation. But time and time alone is required for a positive answer to these interesting inquiries.

FREDERICK C. LEONARD.

1338 Madison Park, Chicago, Ill.,
1913, July 2.

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, May, June, July, 1913.—Owing to the fact that this is a double report of unusual length comment must necessarily be restricted for lack of space.

All our records were broken in the May-June report of observations, the total number of estimates contributed being 1395, the work of eighteen observers on 129 variable stars. Mr. Lacchini heads the list with the splendid total of 256 observations, a record to be proud of. Mr. Lacchini also leads in the June-July report with 237 observations.

* See *P.A.* for June and July, 1913, pp. 366-7.
† See *P.A.* for March, 1913, pp. 168-9.

VARIABLE STAR OBSERVATIONS May, June and July, 1913.

001726
T Androm.

Mo.	Day	Est.	Obs.
6	2	9.8	L
	9	9.1	L
	12	9.2	L
	29	8.4	Ba

001755
T Cassiop.

Mo.	Day	Est.	Obs.
5	25	11.4	J
6	1	10.8	J
	8	10.9	J
	27	10.1	S
	28	10.7	J
7	3	10.3	J

001838
R Androm.

Mo.	Day	Est.	Obs.
6	9	10.3	L
	29	10.5	Ba

004047
U Cassiop.

Mo.	Day	Est.	Obs.
5	25	11.0	L
6	1	10.2	L
	3	10.2	L
	9	9.7	L
	16	8.9	G

004958
W Cassiop.

Mo.	Day	Est.	Obs.
5	25	10.3	J
	31	10.5	J
6	1	10.6	J
	8	10.6	J
7	3	11.3	J

011272
S Cassiop.

Mo.	Day	Est.	Obs.
5	25	9.8	J
6	1	9.5	J
	8	9.4	J
	29	9.3	J
7	3	9.1	J

013238
RU Androm.

Mo.	Day	Est.	Obs.
7	8	12.7	J

013338
Y Androm.

Mo.	Day	Est.	Obs.
6	11	9.7	J
	30	10.1	J
7	3	10.0	J
	8	10.2	J

014958
X Cassiop.

Mo.	Day	Est.	Obs.
6	2	11.6	L

021258
T Persei

Mo.	Day	Est.	Obs.
6	12	9.2	C

021658
S Persei

Mo.	Day	Est.	Obs.
6	12	8.6	C

024356
W Persei

Mo.	Day	Est.	Obs.
5	6	10.2	Le
6	28	10.0	Le
7	2	10.4	Le

033362
U Camelop.

Mo.	Day	Est.	Obs.
5	2	8.0	G

043065
T Camelop.

Mo.	Day	Est.	Obs.
5	7	8.3	Y
	19	8.5	Y
6	2	8.8	Y

043274
X Camelop.

Mo.	Day	Est.	Obs.
5	9	12.6	Y
	19	11.3	Y
	31	10.2	Y
6	2	10.1	Ba
7	7	7.5	O

050953
R Aurigae

Mo.	Day	Est.	Obs.
6	2	12.8	Y

052034
S Aurigae

Mo.	Day	Est.	Obs.
4	30	9.1	L
5	4	9.1	G
	8	9.1	F
	19	8.6	F

053068
S Camelop.

Mo.	Day	Est.	Obs.
5	12	9.7	Y
	31	10.9	Y

053531
U Aurigae

Mo.	Day	Est.	Obs.
5	14	9.3	Y

054319
SU Tauri

Mo.	Day	Est.	Obs.
5	9	9.7	Y

054920
U Orionis

Mo.	Day	Est.	Obs.
4	28	8.4	L
	30	8.1	L
5	5	7.9	L
	9	8.0	L

054974
V Camelop.

Mo.	Day	Est.	Obs.
6	2	11.8	Ba

055353
Z Aurigae

Mo.	Day	Est.	Obs.
5	7	11.0	Y
	31	10.0	Y

060450
X Aurigae

Mo.	Day	Est.	Obs.
5	3	8.8	G

062808
Z Monoc.

Mo.	Day	Est.	Obs.
5	10	8.3	F

063159
U Lyncis

Mo.	Day	Est.	Obs.
5	7	11.8	Ba
	9	12.0	Ba

063558
S Lyncis

Mo.	Day	Est.	Obs.
5	7	13.6	Ba

064932
NOVA GEMIN. 2

Mo.	Day	Est.	Obs.
4	28	8.7	L
	30	8.6	L
5	1	8.7	G
	3	9.1	G
	3	8.7	Bu
	4	8.7	Bu
	4	8.8	L
	5	8.8	Bu
	5	8.9	L
	6	8.6	L
	7	8.7	Bu
	7	8.8	L
	8	8.7	Bu
	8	8.9	C
	9	9.0	L
	9	8.8	Bu
	10	9.1	G
	14	8.9	Y
	18	9.0	L
	20	8.9	L
	20	9.2	G
	22	9.0	G
	24	8.9	L
	24	9.0	G
	25	8.6	C
	28	9.0	G
	28	9.0	L
	30	9.1	G
6	5	9.2	L

065208
X Monoc.

Mo.	Day	Est.	Obs.
5	10	7.5	F

065355
R Lyncis

Mo.	Day	Est.	Obs.
5	7	10.3	Y
	19	10.6	Y
	31	11.1	Y

070310
R Can. Min.

Mo.	Day	Est.	Obs.
4	28	10.7	L
	30	10.7	L
5	5	10.9	L
	7	10.8	L

072708
S Can. Min.

Mo.	Day	Est.	Obs.
4	29	8.6	L
	30	8.6	L
5	3	8.3	G
	3	8.1	Bu
	4	8.4	Bu
	5	8.5	F
	5	8.5	Bu
	5	8.8	L
	7	8.6	L
	7	8.5	Bu
	8	8.4	F
	8	8.4	Bu
	9	8.7	L
	9	8.6	Bu
	10	8.7	G
	10	9.2	M
	18	8.8	L
	19	8.7	Ba
	19	8.7	F
	19	8.8	B
	20	9.0	L
	22	8.8	G
	27	9.2	F
6	2	9.3	F

073508
U Can. Min.

Mo.	Day	Est.	Obs.
4	30	11.2	L
5	5	10.9	L
	5	11.0	F
	7	10.9	L
	7	10.9	Ba
	9	10.7	L
	14	10.7	Y
	19	10.2	Ba
	20	10.0	L
	21	9.8	F
	22	9.6	G
	27	9.5	F

074922
U Geminorum

Mo.	Day	Est.	Obs.
5	7	11.6	B

081112
R Cancri

Mo.	Day	Est.	Obs.
4	28	8.7	L
5	2	8.6	G
	3	8.7	Bu
	5	8.6	L
	5	8.7	Bu
	5	8.8	F
	7	8.5	Bu
	7	8.6	L
	8	8.5	Bu
	8	8.8	C
	9	8.7	Bu

U Geminorum

Mo.	Day	Est.	Obs.
5	9	8.6	L
	20	8.4	L
	21	8.2	F
	24	8.3	L
	28	8.1	F
	28	8.2	L
	30	7.4	G

081617
V Cancri

Mo.	Day	Est.	Obs.
5	2	9.5	G
	5	10.4	F
	21	11.0	F

082405
RT Hydrae

Mo.	Day	Est.	Obs.
4	28	7.7	L
	30	7.8	L
5	2	8.5	G
	5	7.8	L
	7	8.0	L

084803
S Hydrae

Mo.	Day	Est.	Obs.
5	1	10.7	G
	8	10.5	C
	10	11.9	Hu

085120
T Cancri

Mo.	Day	Est.	Obs.
4	30	9.6	L
5	5	9.5	L
	5	9.5	F
	7	9.6	L
	7	9.1	Bu
	8	8.8	B
	8	8.9	Bu
	8	9.6	C
	9	9.1	Bu
	9	9.4	L
	12	9.3	Bu
	15	9.3	Bu
	20	9.6	L
	20	8.8	Ba
	21	9.4	F
	22	9.6	G
	23	9.6	V
	24	9.6	L
	25	9.6	C
	28	9.5	F
	28	9.6	L
6	5	9.7	L

090425
W Cancri

Mo.	Day	Est.	Obs.
5	7	8.6	S
	26	8.9	S

093178
Y Draconis

Mo.	Day	Est.	Obs.
5	7	13.6	Y

VARIABLE STAR OBSERVATIONS May, June and July, 1913.—Continued.

093934
R Leo. Min.

Mo.	Day	Est	Obs.
5	3	10.2	G
	3	10.2	Bu
	4	10.2	Bu
	5	10.0	Bu
	8	10.2	Bu
	10	10.4	G
	11	10.0	Hu
	18	10.5	M
	22	10.4	G
	26	10.8	S
	28	10.5	G
	31	10.4	Hu
6	3	10.8	O

094211
R Leonis

Mo.	Day	Est	Obs.
4	28	7.5	L
	30	7.5	L
5	2	6.8	G
	3	7.1	Bu
	4	7.5	L
	4	7.3	Bu
	5	7.5	Bu
	5	7.8	L
	6	7.5	Le
	6	8.0	L
	6	7.1	B
	7	8.0	L
	7	7.5	Le
	8	7.5	C
	8	7.4	B
	9	7.7	Bu
	9	7.6	Ha
	9	7.5	Le
	9	8.2	L
	10	7.3	G
	10	7.5	M
	10	7.5	Gi
	11	7.5	Le
	12	7.5	Le
	12	7.7	Bu
	14	7.2	B
	15	7.6	Le
	16	7.7	Le
	17	7.7	Le
	18	8.3	L
	18	7.7	M
	19	7.4	Ba
	19	7.7	O
	19	7.9	B
	20	8.0	Bu
	20	8.4	L
	20	7.8	G
	21	8.5	L
	24	8.6	L

R Leonis

Mo.	Day	Est	Obs.
5	25	8.3	C
	25	8.1	Gi
	25	8.0	G
	25	8.4	M
	26	8.6	O
	26	7.7	Ha
	26	8.8	S
	28	8.1	Le
	28	8.2	G
	28	8.7	L
	29	8.5	Le
	30	8.6	C
	30	8.2	G
	30	8.7	L
	31	7.9	Le
	31	8.1	Gi
6	1	8.0	Le
	2	8.1	Le
	2	8.0	Ba
	2	8.3	Y
	3	8.0	Le
	4	8.1	Le
	4	8.8	G
	5	9.0	L
	6	8.3	Le
	7	8.5	Le
	8	8.6	V
	8	8.8	L
	8	8.4	Gi
	8	8.5	Le
	9	8.5	Le
	10	8.4	M
	10	8.4	Le
	11	8.6	Le
	12	8.6	Le
	12	8.0	B
	14	8.8	L
	19	8.7	Le
	21	8.9	L
	22	8.8	Le
	27	10.2	G

094422
Y Hydrae

Mo.	Day	Est	Obs.
5	10	6.6	G
	24	7.0	G

103212
U Hydrae

Mo.	Day	Est	Obs.
4	30	4.8	L
5	5	4.7	Bu
	7	4.8	L
	8	4.7	Bu
	8	5.4	C
	9	4.7	Bu
	9	4.7	L

U Hydrae

Mo.	Day	Est	Obs.
5	11	4.9	Bu
	13	5.0	Bu
	14	4.9	Bu
	18	5.0	Bu
	20	4.8	Bu
	24	4.9	L
	24	5.8	G
	25	5.5	C
	30	5.5	G
	30	5.7	C
6	6	4.7	L

103769
R Urs. Maj.

Mo.	Day	Est	Obs.
5	7	12.0	Y
	7	12.4	B
	14	11.6	Y
	20	11.7	L
	20	11.7	Ba
	21	11.5	L
	22	11.5	L
	23	11.5	L
	24	11.3	Ba
	24	11.4	L
	25	11.4	M
	26	11.4	L
	26	11.0	Ha
	26	10.9	S
	27	11.0	F
	28	11.3	L
	29	11.2	M
	29	10.9	O
	29	10.2	B
	30	10.6	Ha
	31	10.5	Ha
	31	9.6	J
6	1	9.9	L
	1	10.5	O
	1	10.5	Ha
	1	9.9	M
	2	9.7	Ba
	2	10.3	Y
	3	9.7	L
	4	9.7	M
	4	10.0	O
	5	9.7	Ba
	5	9.6	M
	6	9.5	M
	7	8.9	B
	8	9.3	O
	8	9.2	L
	8	9.3	J
	8	9.1	Ba
	9	9.3	O
	9	9.5	Ma
	9	8.8	L

R Urs. Maj.

Mo.	Day	Est	Obs.
6	10	9.2	M
	10	8.6	Ba
	12	9.0	O
	12	8.6	L
	13	8.7	Ba
	14	8.7	B
	14	8.8	L
	18	8.4	Ba
	18	8.2	O
	18	8.5	M
	21	8.2	L
	21	8.4	Ha
	22	8.2	O
	23	8.2	F
	24	8.2	Ba
	24	8.2	M
	24	8.0	O
	24	8.0	S
	26	8.5	Ma
	27	8.1	Ha
	27	8.1	B
	28	8.4	J
	28	8.5	Ma
	28	8.0	O
	28	8.1	Ba
	29	8.0	Ha
	29	7.9	M
	29	8.1	F
	29	8.2	G
	30	8.3	Ba
7	3	8.0	B
	3	8.0	J
	6	7.5	O

104620
V Hydrae

Mo.	Day	Est	Obs.
5	8	7.3	C
	10	6.4	G
	23	6.5	G
	25	7.4	C
	27	6.6	F
	30	6.5	G
	30	7.0	C
6	29	6.5	F

105517
R Crateris

Mo.	Day	Est	Obs.
5	4	8.1	G
	6	8.1	Le
	7	8.1	Le
	10	8.2	G
	11	8.0	Le
	22	8.0	G
	24	8.0	G
	28	8.2	G
	30	8.4	G

110506
S Leonis

Mo.	Day	Est	Obs.
5	7	10.1	Y
6	2	10.7	Y

115919
R Comae Ber.

Mo.	Day	Est	Obs.
5	24	12.0	Ba
	31	10.6	Hu
6	2	11.4	Ba
	2	10.7	Y
	3	10.5	O
	8	10.3	O
	8	9.9	Ba
	10	9.2	Hu
	13	9.7	Ba
	22	9.7	O
	24	9.7	Ba

120905
T Virginis

Mo.	Day	Est	Obs.
5	8	9.5	Y

121418
R Corvi

Mo.	Day	Est	Obs.
5	24	13.0	Ba
	31	12.6	Hu
6	4	12.0	Ba
	8	11.8	Ba
	18	11.0	Ba

122001
SS Virginis

Mo.	Day	Est	Obs.
5	2	7.3	G
	19	7.6	Ba
	29	7.8	G
	31	8.0	Hu
6	2	7.7	Ba
	8	7.9	Ba
	13	7.8	Ba
	24	7.7	Ba
	28	8.1	G

122532
T Can. Ven.

Mo.	Day	Est	Obs.
5	7	10.2	Y
	19	10.2	Y
	23	10.0	V
	30	10.4	V
6	2	10.4	Ba
	2	10.5	Y
	8	10.4	Ba
	8	10.4	V
	13	10.3	Ba
	19	10.4	Ba
	20	10.4	V
	27	10.5	F
	28	10.5	V

123160
T Urs. Maj.

Mo.	Day	Est	Obs.
5	20	12.1	Ba
	24	11.4	Ba
	26	10.5	Hu
	29	11.5	B

VARIABLE STAR OBSERVATIONS May, June and July, 1913.—Continued.

T Urs. Maj.				R Virginis				S Urs Maj.				RU Virginis				R Hydrae			
Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.
6	2	11.2	Ba	5	30	10.2	C	6	10	10.0	M	6	2	9.3	Ba	6	8	7.8	Gi
	2	11.6	Y		31	9.9	Hu		10	9.9	L		2	8.9	B		8	8.1	L
	5	11.0	Ba	6	2	9.9	B		11	9.6	Gi		6	9.5	G		11	8.0	G
	6	11.7	M		2	10.3	O		12	9.7	L		8	9.4	V		19	8.3	G
	7	11.0	B		2	10.0	Ba		12	9.9	M		9	9.2	Ba		21	8.4	L
	8	10.9	J		8	10.0	V		12	9.6	Le		9	9.1	B		29	8.8	G
	8	11.0	Ba		9	10.2	Ba		13	9.9	J		13	9.0	Ba		*132706*		
	8	11.3	L		9	10.2	B		13	9.6	Le		20	10.3	V		S Virginis		
	10	10.6	Hu		10	10.2	Hu		13	9.6	Ba					4	28	10.6	L
	10	11.0	Ba		20	10.8	V		15	9.6	Le		124606			5	1	10.7	L
	10	11.0	L	7	1	10.8	B		18	9.1	O		U Virginis				5	10.9	L
	12	10.8	L						18	9.0	Ba	5	11	9.4	Hu		7	11.1	L
	13	10.9	Ba						19	9.4	J		19	9.4	B		9	10.7	Y
	18	10.6	Ba		123961				19	9.2	Le		24	9.0	Ba		9	11.3	L
	19	10.2	Le		S Urs. Maj.				20	9.1	V		28	8.8	S		24	11.6	L
	21	10.2	Le	4	28	11.3	L		21	9.3	L		29	8.9	B		28	11.8	L
	21	10.3	L	5	6	11.6	Le		21	9.2	Le		31	8.6	Hu	6	2	12.4	Ba
	21	10.8	M		7	11.5	L		21	8.8	M	6	2	8.7	O		9	12.9	Ba
	22	10.6	O		9	11.6	Le		21	9.0	Ha		2	8.6	Ba				
	24	10.2	Le		12	11.6	Gi		22	9.1	Le		2	8.6	B		*133633*		
	24	10.2	Ba		20	11.5	Ba		22	8.9	O		9	8.1	Ba		T Centauri		
	24	10.2	O		21	10.6	L		23	9.2	F		9	8.0	B	5	8	6.5	C
	24	10.0	M		24	11.1	L		24	8.7	S		30	8.6	S		24	6.7	G
	24	10.8	S		24	11.4	Ba		24	8.8	Ba						25	6.7	C
	27	9.8	Hu		25	11.0	J		24	8.7	M		*132422*			6	19	8.4	G
	27	9.6	L		26	11.0	Ha		24	9.0	O		R Hydrae				134440		
	28	9.4	Ba		26	10.5	Hu		26	8.8	Ha	4	28	5.9	L		R Can. Ven.		
	28	8.9	G		26	11.1	L		26	9.0	Ma		29	6.1	L	4	28	8.1	L
	28	10.0	O		27	11.0	F		27	8.8	Hu	5	5	6.4	L		30	8.0	L
	28	9.6	Le		28	11.1	L		27	8.7	B		6	6.5	L	5	2	6.9	G
	28	9.7	J		29	10.5	B		27	9.0	Le		7	6.6	L		2	8.1	L
	28	9.5	Ma		29	11.0	O		28	8.7	V		8	6.2	C		3	7.8	Bu
	29	9.6	Le		29	11.1	L		28	8.7	Ba		9	6.7	L		4	7.8	Bu
	29	9.8	M		30	10.7	Ha		28	8.7	O		9	6.2	Bu		5	8.0	L
	30	9.6	Ba		30	10.9	V		28	9.4	J		10	6.7	Gi		7	7.8	L
	30	9.5	Le		31	10.7	J		28	8.8	G		11	6.8	G		9	8.0	Bu
7	3	8.7	B		31	10.8	M		28	9.0	Ma		11	6.4	Bu		9	7.8	L
	3	9.0	J	6	1	10.9	L		28	9.1	Le		13	6.4	Bu		10	7.3	M
	6	8.6	O		1	10.8	M		29	8.8	Ha		14	6.4	Bu		14	8.1	Bu
					2	10.8	O		29	8.6	M		18	6.5	Bu		17	7.6	B
	123307				2	10.8	Ha		29	9.0	Le		20	7.0	G		18	7.5	Ba
	R Virginis				2	10.4	Ba		29	9.0	F		20	6.4	Bu		18	7.0	M
5	8	8.8	C		2	10.3	Y		30	8.6	Ba		20	7.6	L		18	7.8	Bu
	9	8.4	Bu		3	10.3	J		30	9.0	J		21	7.6	L		18	7.9	L
	11	8.6	Bu		4	10.6	M		30	9.0	Le		22	7.0	F		20	7.9	L
	11	8.9	Hu		5	10.3	J	7	2	8.9	Le		22	7.2	[illegible]		20	7.8	Bu
	12	9.2	O		5	10.5	M		2	9.0	J		22	7.6	L		20	7.8	Ba
	13	8.5	Bu		5	10.4	Ba		3	8.6	B		24	7.7	L		20	7.9	L
	14	8.6	Bu		6	10.2	J		3	9.1	J		24	7.5	G		24	7.7	L
	18	8.8	Bu		6	10.5	M		6	8.5	O		25	8.0	C		25	7.8	Ba
	19	9.3	Ba		7	9.5	B		7	8.9	J		25	7.7	Gi		25	7.1	M
	19	9.4	B		8	10.0	J						27	7.8	L		26	7.7	L
	20	8.4	Bu		8	10.3	L		124204				28	7.9	L		28	7.9	L
	24	9.9	V		8	10.1	V		RU Virginis				29	7.7	L		30	8.1	C
	24	10.3	Ba		8	9.9	B	5	11	9.4	Hu		30	8.1	C	6	1	7.9	L
	25	9.8	C		8	10.4	Gi		24	9.0	Ba		30	7.6	G		2	8.0	Ba
	28	9.9	S		9	9.7	O		24	9.6	V	6	1	7.7	Gi		2	8.3	S
	29	9.5	B		9	10.2	Ma		29	9.0	B		2	7.0	F		2	8.0	Hu
	30	10.2	G		10	9.4	Hu		30	10.0	V		4	7.9	G		3	7.8	L
	30	9.9	V		10	9.7	Ba		31	9.0	Hu		5	8.1	L		4	8.6	M

VARIABLE STAR OBSERVATIONS May, June and July 1913.—Continued.

R Can. Ven.

Mo.	Day	Est.	Obs.
6	6	8.1	M
	8	8.1	L
	9	8.2	Ba
	12	8.2	L
	13	8.2	M
	13	8.2	Ba
	15	8.4	L
	19	8.3	Ba
	23	8.5	L
	23	8.4	O
	24	8.3	M
	24	8.4	Ba
	27	8.4	B
	28	8.4	O
	28	7.8	Ma
	29	8.4	M
	29	8.8	F
	30	8.5	Ba

140412
Z Virginis

5	14	10.5	Y
6	2	11.5	Y

141567
U Urs. Min.

5	3	9.0	Bu
	14	9.2	Bu
	18	8.9	Bu
	19	8.6	Ba
	19	9.2	Bu
	20	9.2	Bu
	25	8.9	J
	26	8.8	S
	31	8.9	J
6	3	9.0	Ba
	8	9.3	J
	9	8.9	Ba
	10	8.9	Hu
	13	9.3	Ba
	19	9.2	Ba
	24	10.0	S
	28	10.0	J
7	3	10.2	J

141954
S Boötis

4	29	10.5	L
5	2	10.5	L
	3	10.0	Bu
	5	10.4	L
	7	10.6	S
	7	10.7	L
	8	9.8	Bu
	8	10.2	Y
	9	9.8	Bu
	10	10.2	Hu
	14	9.8	Bu
	14	9.6	Y
	18	9.9	L

S Boötis

Mo.	Day	Est.	Obs.
5	20	9.5	Ba
	20	9.5	L
	22	9.9	F
	25	9.1	L
	25	9.3	J
	28	9.3	S
	28	9.1	L
	31	9.0	J
6	1	8.9	L
	2	9.1	Ba
	2	8.7	Y
	8	8.9	J
	8	8.7	L
	9	8.6	Ba
	12	8.6	L
	13	8.6	Ba
	19	8.5	Ba
	23	8.5	L
	24	8.4	Ba
	28	8.7	O
	29	8.6	J
	29	8.3	J
	30	8.8	M
	30	8.8	S
7	3	8.6	J
	4	8.5	B
	8	8.7	O

142205
RS Virginis

5	12	13.1	Y
	24	12.0	L
	28	11.6	L
	29	11.5	L
	31	11.2	Y
6	1	11.3	L
	3	10.5	Ba
	5	10.3	L
	6	10.1	L
	8	9.9	L
	9	9.5	Ba
	9	9.8	L
	21	8.6	L

142539
V Boötis

4	28	10.6	L
5	1	10.7	L
	3	10.4	Bu
	4	10.3	G
	4	10.5	Bu
	5	10.9	L
	5	10.5	Bu
	9	10.9	L
	9	10.4	Bu
	10	10.9	Hu
	11	10.0	G
	12	10.7	Gi
	12	11.1	B
	14	10.0	G
	20	9.9	G

V Boötis

Mo.	Day	Est.	Obs.
5	22	10.3	F
	23	9.9	G
	24	10.8	L
	24	10.1	V
	24	10.7	Ba
	25	10.6	Gi
	26	10.1	L
	28	10.3	S
	28	10.1	L
	29	9.9	G
	29	10.3	Gi
	30	10.3	B
	30	10.1	V
6	2	10.1	L
	2	10.6	Hu
	3	10.2	Ba
	6	9.8	M
	8	9.7	L
	8	9.3	V
	8	9.8	Gi
	9	9.7	Ba
	9	9.8	G
	10	9.5	M
	11	9.6	Gi
	12	9.7	L
	13	9.5	Ba
	14	9.7	G
	20	9.1	V
	23	9.1	L
	23	9.2	G
	24	8.6	M
	24	8.6	Ba
	26	9.0	G
	28	9.2	V
	28	8.9	O
	29	8.7	M
	30	9.0	S
7	7	8.5	O

142584
R Camelop.

4	28	8.2	L
5	1	8.3	L
	2	8.3	G
	3	8.2	Bu
	4	8.1	Ba
	5	8.4	L
	7	8.5	B
	7	8.4	L
	9	8.0	Bu
	9	8.3	L
	12	8.1	O
	14	8.3	B
	14	8.0	Bu
	18	8.2	Bu
	19	8.0	Bu
	19	8.1	O
	19	8.2	B
	20	8.0	O
	20	7.9	Bu

R Camelop

Mo.	Day	Est.	Obs.
5	20	8.3	L
	22	8.3	L
	25	8.3	J
	26	8.0	O
	27	8.3	L
	29	8.2	G
	30	8.2	B
	30	8.2	L
	31	8.2	J
6	1	8.0	O
	3	8.2	L
	4	8.0	O
	7	8.3	B
	8	8.3	L
	8	8.1	O
	8	7.9	J
	11	8.0	G
	12	8.4	L
	14	8.2	B
	15	8.5	L
	18	8.1	O
	23	8.5	L
	23	8.2	O
	24	8.5	G
	27	8.4	Hu
	27	8.3	B
	28	8.2	O
	29	8.3	Ba
	29	8.7	J
7	3	8.8	J
	4	8.6	B
	7	8.4	O

143227
R Boötis

4	28	9.3	L
	30	9.6	L
5	1	9.5	L
	5	9.4	L
	9	9.2	L
	9	9.1	Ha
	10	9.2	Hu
	11	8.6	G
	12	8.8	G
	12	9.0	O
	12	9.1	B
	18	8.6	Gi
	18	8.8	L
	19	8.6	B
	20	8.6	O
	21	8.6	L
	23	8.3	G
	23	8.4	L
	24	8.2	Ba
	25	8.1	Gi
	26	7.9	O
	26	8.0	B
	26	8.2	L
	26	8.6	Ha
	28	8.0	S
	28	8.0	L

R Boötis

Mo.	Day	Est.	Obs.
5	29	8.2	G
	30	8.1	G
	30	7.9	B
6	1	7.6	Gi
	1	7.9	L
	1	7.9	O
	2	8.2	Ha
	2	7.9	Hu
	3	8.0	Ba
	4	7.7	M
	6	7.4	G
	8	7.8	L
	8	7.4	O
	9	7.5	Ba
	9	7.3	Gi
	10	7.2	M
	11	7.3	G
	12	7.9	L
	13	7.5	Ba
	14	7.2	G
	15	7.5	L
	23	8.0	L
	23	7.9	O
	24	7.4	Ba
	27	8.0	Ha
	24	8.4	O
	29	9.6	M
	30	8.2	S
7	6	8.6	O

150625
Y Librae

6	5	11.3	Hu

151520
S Librae

5	3	8.4	Bu
	4	8.4	Bu
	5	8.4	Bu
	9	8.5	L
	22	8.6	L
	24	8.3	Ba
	25	8.4	C
	28	8.6	L
	30	8.7	C
6	1	8.6	L
	2	8.4	Ba
	5	8.6	L
	9	8.4	Ba
	10	8.7	L
	21	8.7	L
	27	8.6	G
	28	9.2	Ba

151731
S Cor. Bor.

4	28	8.8	L
5	5	9.8	L
	6	9.6	L
	9	9.6	L
	9	9.8	Ha
	10	9.7	M

VARIABLE STAR OBSERVATIONS May, June and July, 1913.—Continued.

S Cor. Bor.

Mo.	Day	Est.	Obs.
5	10	9.2	G
	19	9.2	B
	20	9.3	Ba
	21	9.9	L
	22	9.6	G
	25	10.3	M
	26	10.2	Ha
	28	10.0	L
	30	9.8	G
	30	10.1	B
6	2	9.6	Y
	2	9.8	Ba
	2	10.3	Ha
	4	10.0	G
	5	10.7	M
	8	10.2	L
	9	9.9	Ba
	13	9.9	Ba
	14	10.8	G
	28	10.5	Ba
	29	11.1	Ha

151822
RS Librae

5	3	7.9	Bu
	4	8.1	Bu
	5	8.1	Bu
	7	8.0	L
	23	7.9	L
	28	7.8	L
	30	7.6	C
6	1	7.8	L
	5	7.8	L
	6	7.7	Ba
	9	7.4	Ba
	10	8.0	L
	21	8.3	L
	28	9.3	Ba

152714
RU Librae

6	28	12.9	Ba
	30	12.8	Ba

153378
S Urs. Min.

4	28	11.9	L
5	1	11.2	L
	6	11.2	L
	7	11.0	L
	9	10.6	L
	10	10.8	Gi
	18	10.5	Gi
	20	10.5	L
	22	10.5	L
	22	10.6	F
	27	10.5	L
	29	10.0	Gi
	30	10.4	L
6	3	10.2	L
	8	9.1	Gi
	9	9.8	L
	15	9.7	L

S Urs. Min.

Mo.	Day	Est.	Obs.
6	23	9.8	L
	29	10.0	G

154428
R Cor. Bor.

4	26	6.0	L
	30	6.0	L
5	2	6.0	L
	3	6.0	Bu
	4	6.0	L
	4	6.0	G
	5	6.0	Bu
	5	6.0	L
	5	5.6	F
	5	5.5	C
	6	6.0	L
	6	5.7	Le
	6	5.4	C
	7	5.6	Le
	7	5.4	C
	8	5.5	C
	8	6.0	L
	9	5.8	Ba
	9	6.0	Ha
	9	6.2	Bu
	9	5.7	Le
	9	6.0	L
	10	6.0	Gi
	10	6.5	M
	10	5.7	G
	11	6.5	M
	11	6.1	J
	11	5.8	B
	11	5.6	Le
	12	6.0	O
	12	5.7	Le
	14	5.6	Ba
	14	5.7	G
	14	6.2	Bu
	14	5.5	C
	15	6.0	Bu
	16	5.8	F
	16	5.7	Le
	17	5.6	Le
	18	5.6	Ba
	18	6.2	Bu
	19	6.0	O
	20	6.1	B
	20	6.0	O
	20	6.4	Bu
	20	5.6	Ba
	21	6.0	L
	22	6.0	L
	22	5.8	G
	22	5.9	F
	23	6.1	L
	25	5.8	Ba
	25	5.4	C
	25	6.0	J

R Cor. Bor.

Mo.	Day	Est.	Obs.
5	25	6.2	M
	26	6.2	O
	26	6.0	Ha
	26	6.0	Hu
	27	5.9	F
	28	6.0	L
	28	6.0	G
	28	5.7	Le
	29	5.9	O
	29	5.8	Le
	30	5.7	B
	30	5.8	G
	30	5.7	C
	30	5.8	Le
	31	5.7	Le
	31	6.1	J
6	1	6.0	O
	1	6.1	Ba
	1	5.6	Le
	2	6.0	L
	2	5.9	F
	2	6.2	O
	2	6.2	Ha
	2	5.7	Le
	2	5.6	Ba
	3	5.8	Ba
	4	6.0	O
	4	5.6	Ba
	4	5.7	Le
	5	6.0	L
	5	5.8	Ba
	5	6.0	Hu
	5	6.2	M
	5	5.7	Le
	6	6.0	G
	6	6.3	Ba
	6	5.7	Le
	6	6.1	J
	7	5.8	Le
	8	5.9	Le
	8	6.0	Gi
	8	5.8	Ba
	8	6.0	O
	8	6.1	J
	9	6.0	O
	9	6.0	L
	9	6.0	Ba
	9	5.9	Le
	9	6.0	G
	10	6.2	Ba
	10	5.7	Le
	11	6.2	Ba
	11	5.8	Le
	12	6.0	B
	12	6.2	O
	12	5.8	C
	12	6.2	Ba
	12	5.8	Le
	13	6.2	Ba
	13	5.8	Le
	14	6.2	G
	15	5.9	Le

R Cor. Bor.

Mo.	Day	Est.	Obs.
6	18	5.8	Ba
	18	6.1	O
	19	6.0	Ba
	19	5.9	Le
	21	6.0	Le
	22	6.0	O
	22	5.7	J
	22	6.1	Le
	23	6.0	L
	23	5.8	F
	23	6.2	G
	24	6.0	Ba
	24	5.9	O
	24	5.9	Le
	26	6.2	G
	26	5.8	Ma
	27	6.0	Le
	28	6.0	Ba
	28	6.0	O
	28	5.9	J
	28	6.2	Le
	29	6.2	Le
	29	6.2	Ha
	29	6.0	Ba
	29	5.9	F
	30	6.1	M
	30	6.1	Le
	30	6.0	Ba
	30	6.1	J
7	2	6.0	J
	2	6.4	Le
	3	6.1	J
	6	6.0	O
	7	6.0	J
	8	6.0	O

154536
X Cor. Bor.

5	31	12.7	J
6	8	12.8	J
	11	12.9	J

154539
V Cor. Bor.

5	4	8.7	G
	4	9.4	Ba
	10	9.1	G
	12	9.5	O
	20	9.5	O
	22	9.5	G
	26	9.5	O
	28	9.6	G
6	5	10.0	M
	6	9.8	G
	10	9.2	Hu
	12	9.3	Ba
	14	10.4	G
	28	9.8	Ba

154615
R Serpentis

5	1	7.2	G
	3	7.0	Bu
	4	7.0	Bu

R Serpentis

Mo.	Day	Est.	Obs.
5	4	7.2	G
	5	7.2	Bu
	7	6.4	Ba
	8	7.4	C
	8	6.8	Bu
	9	6.8	Bu
	10	6.8	Bu
	10	7.1	G
	11	7.3	M
	12	6.6	O
	20	7.0	O
	22	6.8	G
	25	7.0	Ba
	25	6.6	G
	26	7.0	O
	28	6.5	G
	29	7.1	O
	30	7.6	C
	31	7.6	M
6	1	7.4	O
	3	7.4	O
	4	7.4	Ba
	4	7.7	M
	6	6.6	G
	8	7.4	O
	9	7.4	O
	11	7.2	G
	12	7.6	Ba
	12	7.9	O
	12	8.0	C
	18	7.8	B
	18	8.1	O
	22	8.1	O
	24	8.1	O
	27	7.8	G
	28	8.1	O
	29	8.0	Ba
	29	8.0	G
7	6	8.6	O
	8	8.4	O

155847
X Herculis

4	28	6.3	L
5	5	6.4	L
	9	6.4	L
	20	6.3	L
	24	6.3	L
6	2	6.2	L

155823
RZ Scorpii

5	28	7.6	G
6	11	8.3	G
	20	8.6	G
	23	8.7	G
	24	8.9	G
	26	9.0	G
	27	8.9	G

160210
U Serpentis

5	7	13.6	Ba
	25	12.6	Ba

VARIABLE STAR OBSERVATIONS May, June and July, 1913—Continued.

U Serpentis			
Mo.	Day	Est.	Obs.
6	4	11.6	Ba
	23	9.4	Ba
	28	9.4	O
	28	9.0	O
	29	9.2	Ba
7	6	8.7	O

160625

RU Herculis			
5	7	13.8	Ba
	7	12.0	B
	12	11.3	F
6	4	13.4	Ba
	5	10.9	Hu
	29	12.8	Ba

161138

W Cor. Bor.			
5	29	9.0	O
6	9	9.8	Ba
	12	9.9	Ba
	29	11.1	Ba

162119

U Herculis			
5	3	9.0	Bu
	4	9.2	G
	4	9.2	Bu
	5	9.4	Bu
	7	9.2	Ba
	7	9.1	B
	10	9.2	G
	11	9.6	M
	12	9.4	O
	14	9.5	S
	18	9.0	Ba
	20	9.5	O
	22	9.3	G
	24	9.5	V
	25	9.8	M
	26	10.0	O
	28	9.7	S
	30	9.4	G
	31	9.5	B
	31	9.8	Ha
	31	9.6	V
	31	9.6	Y
	31	10.2	M
6	2	9.8	O
	3	9.3	Ba
	4	10.4	M
	4	9.5	G
	5	9.4	Hu
	8	9.6	V
	9	9.9	Ma
	10	10.5	M
	12	10.7	M
	12	9.4	Ba
	12	9.5	B
	20	10.1	V
	23	9.8	Hu
	24	10.4	S
	28	10.1	V

U Herculis			
Mo.	Day	Est.	Obs.
6	28	10.7	Ma
	29	10.2	M
	29	10.2	S
	29	9.9	Ba
	29	10.8	Ha

162212

V Ophiuchi			
5	3	9.0	Bu
	4	9.0	Bu
	5	8.2	Bu
	30	9.8	C

162807

SS Herculis			
5	25	10.2	G

163172

R Urs. Min.			
5	3	9.8	Bu
	4	10.0	Bu
	7	9.8	B
	8	10.0	Bu
	9	9.8	Bu
	10	9.8	Bu
	14	9.8	Bu
	17	9.9	B
	20	9.8	B
	30	9.9	B
6	3	9.9	O
	6	10.1	Ba
	12	9.8	Ba
	23	9.3	O
	27	9.3	B
	30	9.3	Ba

163137

W Herculis			
5	9	9.5	Ba
	12	9.3	O
	14	9.6	Y
	18	9.4	Ba
	23	8.7	G
	25	8.8	G
	26	9.8	O
	28	8.9	G
	30	9.0	G
	31	10.5	Y
	31	10.2	F
6	2	10.1	F
	4	9.3	Ba
	4	10.5	M
	4	9.9	G
	11	10.4	G
	11	10.3	F
	11	10.8	M
	12	9.3	Ba
	23	10.6	F
	27	10.7	Le
	29	11.4	F
	29	9.3	Ba

163266

R Draconis			
Mo.	Day	Est.	Obs.
5	20	10.8	Ba
	21	10.8	F
	22	11.0	L
	26	10.1	S
	27	10.4	F
	27	10.7	L
	29	9.9	O
	29	10.4	Y
	30	9.8	B
	30	10.0	L
	31	9.8	J
6	1	10.0	O
	1	9.9	M
	2	9.9	O
	2	10.2	F
	2	9.4	L
	4	9.6	Ba
	5	9.7	M
	6	9.5	L
	8	9.5	O
	8	9.7	J
	10	9.4	L
	10	9.6	M
	11	9.5	F
	12	9.3	Ba
	18	9.3	O
	21	9.1	L
	22	9.3	O
	23	9.2	F
	24	9.0	O
	24	8.8	S
	28	8.6	O
	28	8.9	J
	28	9.1	G
	29	8.6	Ba
	29	9.0	F
7	3	8.7	J
	6	8.4	O
	8	8.2	O

164715

S Herculis			
5	7	12.1	Ba
	7	11.1	B
	12	11.3	Y
	31	11.1	B
6	5	12.6	Ba
	14	10.6	B
	21	11.8	M
	23	10.0	F
	28	11.1	J
	29	10.5	F
	29	11.6	Ba
7	3	11.0	J

165030

RR Scorpii			
5	1	8.7	G
	30	8.3	G
6	20	8.6	G

RR Scorpii			
Mo.	Day	Est.	Obs.
6	26	8.7	G
	27	8.8	G

165631

RV Herculis			
5	7	11.1	B
	7	11.0	Ba
	10	11.0	G
	11	11.2	M
	12	11.5	Y
	12	11.4	F
	22	11.2	F
	25	11.0	M
	26	10.6	O
	27	11.3	F
	29	11.5	Y
	31	10.9	B
6	2	10.9	O
	2	11.2	F
	4	11.0	M
	5	11.4	Ba
	21	12.3	M
	23	13.0	Hu

170215

R Ophiuchi			
5	22	11.4	F

171401

Z Ophiuchi			
5	24	7.8	V
	31	7.6	V
6	8	7.7	V
	25	7.7	V
7	8	8.5	O

175458

T Draconis			
5	21	10.8	F
	24	10.6	V
	27	10.8	F
	31	10.6	V
6	2	10.6	F
	8	10.6	V
	20	9.5	G
	25	10.6	V

175519

RY Herculis			
6	5	12.0	Ba
	30	10.2	Ba

180531

T Herculis			
4	28	8.5	L
	30	8.1	L
5	5	8.3	L
	6	8.4	L
	7	8.5	B
	7	8.3	Ba
	8	8.4	C
	9	8.2	L
	10	8.4	G
	10	8.3	Gi

T Herculis			
Mo.	Day	Est.	Obs.
5	11	8.1	M
	14	8.1	C
	17	8.1	B
	18	8.3	Ba
	18	8.2	L
	20	8.1	L
	22	8.3	G
	24	8.1	L
	24	8.3	V
	25	8.2	Gi
	25	8.4	C
	25	8.0	M
	25	8.4	G
	26	8.7	O
	27	8.2	L
	28	8.2	S
	29	8.3	Gi
	29	8.2	L
	30	8.5	C
	31	8.3	B
	31	7.9	Ha
	31	8.0	M
	31	8.2	V
6	1	8.3	Gi
	1	8.7	O
	4	8.4	G
	4	7.9	M
	4	8.7	O
	5	8.5	Ba
	5	8.9	Hu
	5	8.5	L
	8	8.9	O
	8	8.5	V
	8	8.5	Gi
	10	8.9	L
	10	8.8	M
	12	9.0	C
	12	8.9	O
	12	9.1	Ba
	12	9.0	B
	13	9.0	M
	14	9.1	L
	21	9.8	L
	22	9.6	O
	23	10.6	Hu
	25	10.7	V
	28	10.2	O
	29	10.0	Ha
	29	10.0	M
	29	10.2	G
	30	10.3	Ba

181136

W Lyrae			
5	7	9.0	Ba
	7	9.4	Y
	9	9.0	Le
	12	9.0	Le
	12	8.4	M
	14	8.9	Y
	16	9.0	Le

VARIABLE STAR OBSERVATIONS May, June and July, 1913—Continued.

W Lyrae				X Ophiuchi				X Lyrae				R Cygni				TT Cygni			
Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.
5	17	9.1	Le	5	14	8.4	Ba	5	1	9.3	G	5	29	9.9	M	5	4	7.9	G
	18	8.7	Ba		30	9.0	C		30	9.2	G		29	9.9	Le		14	7.3	G
	25	8.3	G	6	1	8.6	Ba	6	4	9.2	O		30	10.0	M		27	7.5	F
	26	9.0	O		5	9.0	Ba		23	9.3	O		30	9.9	Le		29	8.2	O
	28	8.7	Le		12	8.9	Ba		24	9.2	G		30	9.6	Ha		29	7.8	G
	29	8.7	Le		12	8.9	C		28	9.2	O		30	9.8	B		30	8.1	C
	30	8.7	Le		30	8.4	Ba	7	8	9.2	O		30	9.7	G	6	2	7.4	B
	31	8.8	Le										31	10.5	V		8	7.3	L
6	1	9.1	O		*184205*				*191033*				31	10.1	Le		9	8.0	O
	1	8.7	Le		R Scuti				RY Sagittarii			6	1	10.1	L		10	8.0	Hu
	2	9.0	Y	4	28	5.4	L	6	12	9.1	C		1	9.9	Ba		12	8.1	C
	2	8.7	Le		30	5.4	L						1	10.0	Le		12	8.1	L
	3	8.6	Le	5	2	5.2	L		*191019*				2	10.2	L		15	7.9	L
	4	8.3	O		5	5.2	L		R Sagittarii				3	10.1	Le		19	8.0	G
	4	8.6	Le		7	5.0	L	6	3	10.1	L		4	10.2	Le		22	8.3	O
	4	8.3	M		8	5.2	L		9	9.7	L		4	10.2	M		23	8.2	F
	4	8.3	G		9	5.1	L		29	9.0	F		5	9.7	B		23	8.2	L
	5	8.4	Ba		10	5.9	G						5	10.4	L		23	8.1	Hu
	5	8.3	Hu		14	5.4	C		191350				6	10.3	M		28	7.5	B
	7	8.7	Le		16	5.0	F		TZ Cygni				7	10.2	Le		28	8.2	O
	8	9.0	O		18	5.3	L	4	30	10.5	L		8	10.4	Ba		29	7.9	F
	9	8.5	O		20	5.2	L	5	9	10.8	L		8	11.0	V	7	4	7.6	B
	9	8.7	Le		24	6.0	G		24	10.5	L		8	9.7	B		7	8.0	O
	10	8.7	Le		24	5.0	L	6	5	10.5	L		9	9.9	Ha		194048		
	11	8.6	Le		25	5.1	L						9	10.5	Gi		RT Cygni		
	11	8.3	Ba		26	5.1	L		191637				9	10.4	Ma	4	28	9.1	L
	12	8.3	M		27	5.4	F		U Lyrae				9	10.3	Le		30	9.3	L
	12	8.2	B		28	5.1	L	6	6	11.0	Ba		10	10.3	Le	5	1	8.4	G
	12	8.1	O		30	5.5	G						11	10.4	Le		5	9.0	F
	12	8.5	Le		30	5.5	C		193449				12	10.5	L		6	9.3	L
	12	8.8	C		31	5.5	M	4	28	9.8	L		12	10.8	Ba		9	9.3	L
	13	8.2	Le	6	1	5.1	L	5	1	9.2	G		12	10.5	M		9	9.2	Le
	15	8.3	Le		1	5.2	Ba		2	9.2	G		12	10.3	Le		11	8.6	G
	18	8.2	B		2	5.4	F		5	9.6	F		13	10.5	Le		12	9.3	Le
	18	8.1	O		2	5.1	L		6	9.8	L		15	10.6	Le		12	9.5	M
	19	8.4	G		3	5.2	L		9	9.9	L		19	10.5	Le		16	9.6	Le
	19	8.1	Le		5	5.2	Ba		9	9.3	Le		21	10.5	Le		18	9.7	M
	21	8.1	Le		5	5.1	L		11	9.3	G		21	10.4	Ha		18	9.5	Ba
	22	8.0	O		6	5.1	G		12	9.6	M		21	11.0	M		18	10.0	L
	22	8.1	Le		8	5.2	L		12	9.5	Gi		21	11.2	L		20	10.0	L
	24	8.2	Le		9	5.3	L		12	9.4	Le		22	10.4	Le		22	10.0	L
	24	8.5	G		10	5.5	Hu		16	9.5	Le		23	10.8	F		22	9.7	G
	27	8.1	Le		10	5.3	L		18	10.0	L		24	10.4	Le		24	10.1	L
	27	7.9	B		12	5.5	Ba		18	9.4	Ba		24	11.5	Ba		25	10.0	Gi
	28	8.1	Le		12	5.5	C		18	9.8	M		25	11.3	V		27	10.1	F
	28	7.8	O		14	5.4	L		20	9.6	G		26	11.2	Ma		28	9.9	G
	28	8.4	G		15	5.3	L		20	10.0	L		27	11.0	Hu		28	10.3	L
	29	8.1	M		20	5.7	G		22	9.6	G		27	10.6	Ha		28	9.8	Le
	29	8.1	Le		21	5.4	L		22	9.9	L		27	10.4	Le		29	9.7	Le
	30	8.1	Ba		23	5.8	F		24	10.5	V		28	10.4	Le		29	10.1	M
	30	8.1	Le		23	5.4	L		24	10.0	L		28	10.5	B		29	10.0	Gi
7	2	8.0	Le		26	5.8	G		25	9.9	Gi		29	10.4	Le		30	9.9	Le
	3	8.0	B		26	5.6	Ha		26	10.5	O		29	10.9	Ha		30	10.0	G
	7	7.8	O		27	5.5	Hu		26	9.5	B		29	11.0	F		30	10.2	M
					28	5.7	G		26	9.7	Ha		30	10.4	Le		31	9.9	Le
					29	5.3	Ba		27	9.9	F		30	12.0	Ba	6	1	10.4	L
	183225				29	5.1	M		28	10.0	L	7	2	10.5	Le		1	10.4	Le
	RZ Herculis				29	5.8	F		28	9.8	G		4	10.7	B		1	10.1	Ba
6	5	12.4	Ba		30	5.2	Ba		29	10.9	S						2	10.4	Le
	30	12.8	Ba	7	7	5.7	O		28	9.6	Le						3	10.5	Le

VARIABLE STAR OBSERVATIONS May, June and July, 1913—Continued.

RT Cygni

Mo.	Day	Est.	Obs.
6	4	10.3	M
	4	10.5	Le
	5	10.8	L
	6	10.5	M
	7	10.9	Le
	8	11.0	L
	8	11.0	Ba
	9	10.9	Le
	9	10.8	Gi
	10	11.0	Le
	11	11.1	Le
	12	10.8	M
	12	11.2	Ba
	12	11.0	Le
	21	11.0	M
	22	11.0	Le
	24	11.0	Le
	27	11.0	Le
	27	10.7	Hu
	28	10.9	Le
	29	10.9	Le
	29	10.7	Hu
	30	11.3	Ba
	30	10.9	Le
7	2	10.9	Le
	4	11.0	B

194248

TU Cygni

5	1	10.8	G
	24	9.6	L
	25	9.8	Gi
	27	9.3	F
	28	9.3	L
	29	9.5	M
	29	9.4	Gi
6	1	9.2	L
	1	9.7	Ba
	4	9.2	M
	5	9.3	L
	6	9.1	M
	8	9.2	L
	9	9.1	Gi
	12	9.3	L
	12	9.5	Ba
	18	9.4	M
	21	9.7	M
	23	9.3	F
	29	9.4	Hu
	29	9.1	F
	39	9.4	Ba

194632

χ Cygni

6	21	11.4	Ha
	23	11.2	Hu
	27	11.0	Ha

200525

W Vulpeculae

6	24	10.0	O

200647

SV Cygni

Mo.	Day	Est.	Obs.
5	4	9.1	G
	5	9.2	F
	9	9.3	Ba
	9	9.2	L
	12	9.5	M
	14	9.6	G
	24	9.4	L
	27	9.3	F
	28	9.5	L
	29	9.1	M
	30	8.9	B
	30	9.1	G
	30	9.3	C
6	1	9.2	O
	2	9.5	L
	5	8.8	B
	6	8.7	Ba
	8	9.6	L
	12	9.6	L
	12	8.8	Ba
	12	9.3	M
	12	9.5	C
	13	9.3	M
	17	9.1	M
	19	9.2	G
	22	8.8	O
	23	9.0	F
	23	9.5	L
	27	9.0	G
	28	8.5	B
	29	9.1	F
	30	8.2	Ba
7	3	8.8	B

200715 a

S Aquilae

5	12	11.3	Gi
	13	11.1	F
	27	10.0	F
	29	10.1	Gi
	31	10.0	M
6	1	10.1	Gi
	8	9.9	Gi
	23	10.0	F
	24	9.6	M
	27	9.7	B
	29	9.9	N
7	3	9.4	B

200715 b

RW Aquilae

5	13	9.4	F
	27	9.5	F
6	23	9.5	F
	24	9.3	M
	27	9.1	B
	29	9.5	M
7	3	9.2	B

200822

W Capricorni

6	11	11.4	F

200916

R Sagittae

Mo.	Day	Est.	Obs.
5	13	9.3	F
	27	9.2	F
6	23	9.3	F
	27	9.0	B
7	3	8.9	B

200938

RS Cygni

5	4	7.4	G
	6	8.8	L
	9	8.6	L
	12	8.0	Gi
	15	7.4	G
	18	8.1	F
	22	8.6	L
	23	8.9	L
	24	8.7	L
	25	8.0	Gi
	25	9.1	J
	26	8.9	L
	27	8.0	F
	28	8.9	L
	29	8.6	L
	31	9.2	J
6	1	8.8	L
	2	8.0	O
	2	8.8	L
	4	8.3	Le
	4	8.5	G
	5	8.8	L
	7	8.2	Le
	8	9.0	J
	8	8.7	L
	9	8.2	Le
	10	8.1	Le
	11	8.2	Le
	11	8.3	F
	12	8.1	Le
	12	9.0	L
	13	8.2	Le
	15	8.8	L
	18	8.0	O
	19	8.2	Le
	19	8.1	G
	21	8.6	L
	21	8.1	Le
	22	8.0	Le
	23	8.2	F
	24	8.2	O
	24	8.1	Le
	27	8.1	Le
	27	8.2	Ha
	28	8.2	O
	28	9.0	J
	28	8.0	Le
	29	8.3	F
	29	8.0	Le
	29	7.8	G
	30	8.0	Le

RS Cygni

Mo.	Day	Est.	Obs.
7	2	7.9	Le
	3	8.8	J

201008

R Delphini

5	31	9.0	V
6	1	12.9	Ba

201139

RT Sagittarii

6	12	10.7	C

201121

RT Capricorni

5	13	7.2	F
	15	6.5	G
6	3	8.2	L
	11	7.3	F
	29	7.0	F

201130

SX Cygni

5	7	10.8	Y
	12	11.0	Y
	29	11.2	Y

201647

U Cygni

4	28	8.2	L
5	4	7.6	G
	5	7.8	F
	6	7.9	L
	9	7.9	L
	12	7.5	Gi
	14	7.5	G
	20	7.7	L
	20	7.3	G
	21	7.5	L
	24	7.5	L
	25	7.4	Gi
	25	8.1	J
	25	7.2	G
	27	7.0	F
	28	7.5	L
	28	7.4	S
	29	6.8	M
	29	7.1	O
	30	7.1	G
	31	8.0	J
6	1	7.7	L
	1	7.3	Gi
	2	7.0	L
	4	7.3	O
	8	7.7	L
	8	7.3	O
	8	7.8	J
	9	7.2	G
	9	7.3	Gi
	12	7.4	L
	13	7.1	M
	15	7.4	L
	17	7.0	M
	18	7.3	O
	19	7.2	G

U Cygni

Mo.	Day	Est.	Obs.
6	22	7.3	O
	23	6.8	F
	23	7.4	L
	27	7.1	G
	28	7.9	J
	28	7.4	O
	29	7.2	F
	30	7.5	Ba
7	3	7.7	J
	7	7.4	O

202339

RW Cygni

5	4	8.2	G
	12	9.3	M
	14	9.0	G
	20	8.2	G
	22	7.9	G
	24	8.0	G
	28	8.1	G
	29	8.9	M
	29	7.9	G
6	4	8.0	G
	9	8.3	G
	12	8.9	M
	14	8.3	G
	17	8.7	M
	19	7.9	G
	21	8.7	M
	25	9.0	M
	27	7.9	G
	30	9.0	M

202846

TV Cygni

5	9	9.6	L
	24	9.5	L
6	5	9.5	L
	9	9.7	L
	23	9.7	L

202946

SZ Cygni

5	5	9.6	F
	6	9.7	Le
	9	9.7	L
	9	9.6	Le
	9	9.6	Ba
	12	9.2	Le
	16	9.4	Le
	17	9.6	Le
	18	9.8	F
	24	9.7	L
	27	9.1	F
	28	9.5	Le
	29	9.3	Le
	30	9.3	Le
	30	8.9	B
	31	9.2	Le
6	1	9.1	Ba
	1	9.1	Le
	2	9.1	Le
	3	9.5	Le

VARIABLE STAR OBSERVATIONS May, June and July, 1913—Continued.

SZ Cygni

Mo.	Day	Est.	Obs.
6	4	9.5	Le
	5	9.8	L
	6	9.8	Le
	6	9.5	Ba
	7	9.7	Le
	8	9.0	L
	9	9.6	L
	9	9.6	Le
	10	9.7	L
	10	9.6	Le
	11	8.7	F
	11	9.5	Le
	12	8.7	Ba
	12	9.5	L
	12	8.8	B
	13	9.2	Le
	15	9.2	Le
	15	9.5	L
	19	9.5	Le
	21	9.7	Le
	21	9.7	L
	22	9.6	Le
	23	9.6	F
	23	9.9	L
	24	9.5	Le
	24	8.8	Hu
	27	8.9	Le
	28	8.8	B
	28	8.9	Le
	29	8.8	Hu
	29	9.0	Le
	29	9.3	F
	30	9.0	Ba
	30	9.2	Le
7	2	9.4	Le
	3	9.0	B

202954
ST Cygni

6	6	11.7	Ba

203847
V Cygni

5	22	9.6	G
	25	9.4	G
	28	9.3	G
	29	9.6	O
	30	9.2	G
	30	9.3	J
6	1	10.1	J
	4	9.3	G
	8	9.6	J
	9	9.7	O
	9	9.3	G
	19	9.2	G
	22	9.8	O
	23	9.2	F
	24	9.9	O
	24	9.0	G
	28	9.6	O

V Cygni

Mo.	Day	Est.	Obs.
6	29	9.0	G
	29	9.3	J
	30	9.3	J
7	3	9.3	J
	7	9.6	O

203816
S Delphini

5	31	11.3	Y

203935
X Cygni

6	19	6.0	G
	24	6.2	G
	26	6.2	G
	28	6.3	G

204405
T Aquarii

5	31	10.4	V
6	1	10.4	J
	5	10.5	J
	8	9.7	V
	8	9.9	J
	25	8.8	V
	28	8.9	J
	29	8.8	Ba
7	3	8.7	J

204846
RZ Cygni

6	2	12.4	Y

205923
R Vulpeculae

5	2	8.4	L
	5	8.5	L
	7	8.5	L
	18	8.9	L
	19	9.2	J
	24	9.0	L
	25	9.4	J
	28	9.2	L
	31	9.5	Ba
	31	9.6	J
6	1	9.3	Gi
	1	9.5	L
	3	9.4	L
	6	9.7	Ba
	8	10.3	J
	8	9.8	L
	9	10.3	L
	12	10.5	Ba
	12	11.0	L
	23	11.6	L
	28	11.3	J
	29	9.9	Hu
7	3	11.3	J

210116
RS Capricorni

5	13	8.2	F
	15	8.1	G

RS Capricorni

Mo.	Day	Est.	Obs.
5	16	8.3	F
	23	8.2	G
6	2	8.5	F
	11	8.0	F
	12	8.3	C
	16	8.1	G
	26	8.5	G
	29	8.1	F

210868
T Cephei

4	28	9.5	L
	30	9.1	L
5	5	9.0	L
	6	9.0	L
	7	9.0	L
	7	8.4	B
	9	9.0	L
	12	8.4	Gi
	18	8.4	Gi
	19	8.3	B
	20	8.7	L
	22	8.8	L
	25	8.7	J
	27	8.5	L
	29	8.2	Gi
	30	8.6	L
	31	8.0	Ba
	31	8.8	J
6	2	9.0	O
	2	8.6	S
	3	8.6	L
	6	8.1	Ba
	8	8.6	O
	8	8.5	J
	8	8.4	L
	8	7.8	Gi
	11	7.4	B
	12	7.9	L
	15	8.0	L
	18	7.3	B
	18	7.9	O
	18	8.2	M
	19	7.5	Ba
	22	8.0	O
	23	7.8	L
	24	8.3	M
	25	7.6	V
	26	8.4	Ma
	27	8.0	S
	28	7.7	O
	28	7.8	J
7	3	8.0	J
	6	7.7	O

213244
W Cygni

4	28	5.7	L
	29	5.9	L

W Cygni

Mo.	Day	Est.	Obs.
5	1	6.1	G
	2	6.1	L
	5	6.0	L
	6	6.2	L
	7	6.1	L
	8	6.6	L
	9	6.2	L
	14	5.9	G
	18	6.3	L
	20	6.2	L
	21	6.3	L
	22	6.1	L
	23	6.1	L
	24	6.0	L
	25	6.1	L
	26	6.1	L
	28	6.0	L
	29	6.0	L
	30	5.5	G
	30	6.7	C
6	1	6.0	L
	2	6.0	L
	3	6.0	L
	5	5.9	L
	8	5.9	L
	9	5.9	L
	14	5.8	L
	15	5.8	L
	21	5.5	L
	23	5.9	O
	23	5.5	L
	29	6.1	G
	28	6.0	O
7	7	5.9	O

213678
S Cephei

5	7	8.7	B
	19	8.5	B
	31	8.5	Ba
	31	9.6	J
6	2	9.3	O
	2	9.8	S
	8	9.5	J
	11	8.1	B
	18	8.2	B
	18	8.1	O
	19	8.6	B
	25	8.3	V
	27	9.2	S
	28	8.1	O
	28	8.9	J
7	3	9.3	J

213753
RU Cygni

5	12	8.8	G
	31	8.2	V
6	8	7.9	V
	23	8.4	F
	23	9.3	O
	24	8.5	G
	25	8.6	V

RU Cygni

Mo.	Day	Est.	Obs.
6	29	9.0	F
7	7	9.2	O

213843
SS Cygni

5	1	11.6	G
	2	11.7	G
	2	11.8	L
	4	11.7	G
	5	11.9	L
	7	12.0	Y
	7	11.9	L
	8	11.9	Ba
	9	11.9	J
	11	11.6	J
	12	11.9	J
	12	11.8	Gi
	12	11.5	G
	13	11.4	F
	15	11.9	J
	15	11.5	G
	15	11.5	Ba
	16	10.0	F
	18	8.4	F
	18	8.7	Ba
	18	8.4	L
	19	8.6	Ba
	19	8.3	J
	20	8.4	Ba
	20	8.4	G
	20	8.3	L
	20	8.3	J
	21	8.4	F
	22	8.4	G
	22	8.1	L
	23	8.5	G
	23	8.1	L
	24	8.2	L
	24	8.6	Ba
	24	8.3	G
	25	8.6	Gi
	25	8.4	J
	25	8.5	G
	25	8.3	L
	26	8.3	L
	26	8.3	J
	27	8.3	F
	27	8.4	L
	28	8.4	G
	28	8.4	L
	28	8.8	J
	29	9.3	J
	29	8.8	G
	29	8.5	L
	29	8.3	M
	29	9.2	O
	29	9.3	Gi
	29	9.3	B
	29	8.9	Le
	30	9.6	G
	30	9.8	G

VARIABLE STAR OBSERVATIONS May, June and July, 1913.—Continued.

SS Cygni				SS Cygni				SS Cygni				RV Cygni				V Cassiop.			
Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.	Mo.	Day	Est.	Obs.
5	30	9.9	Le	6	10	11.8	Ba	7	7	11.0	J	6	9	8.0	L	5	16	7.8	F
	31	9.4	M		11	11.9	Gi			10.6	J		10	7.7	Le		19	8.0	J
	31	10.2	Le		11	11.8	Ba			10.1	J		11	7.5	F		25	8.3	J
	31	10.0	Ba		11	11.7	J			10.2	J		11	7.8	Le		27	9.0	F
	31	10.1	V		12	11.9	Ba		8	10.6	J		12	7.5	Le	6	1	9.1	J
	31	9.7	J		13	11.7	Ba		8	10.2	O		13	7.6	Le		8	9.5	J
	31	10.2	J		13	11.8	J						19	7.4	Ba		28	11.0	J
6	1	10.0	L		17	11.9	Ba			213937			19	7.8	Le	7	3	11.1	J
	1	10.3	Gi		18	12.0	Ba			RV Cygni			21	7.6	Le				
	1	10.9	Ba		21	12.0	M	5	2	7.6	G		22	7.7	Le			233335	
	1	10.6	Le		23	11.9	L		4	7.5	G		23	8.1	L			ST Androm.	
	2	11.4	F		24	12.0	Ba		9	7.2	F		23	8.0	F	5	25	10.5	Ba
	2	11.0	O		25	11.9	J		11	7.7	G		24	7.8	Le	6	16	9.8	G
	2	11.1	L		27	12.0	Hu		12	7.8	Le		24	7.3	G		29	9.6	Ba
	2	11.6	Ba		27	12.0	Le		14	8.4	C		24	7.8	Hu		30	9.1	Ba
	3	10.9	J		28	12.4	B		16	7.6	Le		27	7.8	Hu				
	3	11.7	Ba		28	11.9	Ba		18	7.5	F		27	7.6	Le			235182	
	3	11.5	Le		28	11.9	J		22	7.1	G		28	7.5	B			V Cephei	
	3	11.3	L		28	12.0	Le		24	8.1	L		28	7.8	J	5	8	6.6	C
	4	11.2	J		29	11.8	Le		25	8.3	J		29	8.0	F		30	6.6	C
	4	11.7	Ba		29	11.7	Ba		27	7.5	F		29	7.6	Le				
	4	11.9	Le		29	11.5	F		28	7.6	Le		29	7.6	G			235350	
	5	11.7	Ba		29	11.6	J		29	7.8	Le		30	7.5	Le			R Cassiop.	
	5	11.8	L		29	12.0	Hu		30	8.3	C	7	2	7.5	Le	5	16	10.6	F
	5	11.6	J		30	11.9	Le		31	7.9	J		3	8.3	J		25	10.9	J
	5	12.0	B		30	11.9	J		31	7.7	Le		3	7.3	B	6	1	10.3	J
	6	11.7	J		30	11.7	Ba	6	1	7.5	Le		7	7.8	O		1	11.0	L
	6	11.7	Ba	7	2	11.8	J		1	7.8	L			*225120*			8	10.2	J
	7	11.7	J		2	12.0	Le		3	7.6	Le			S Aquarii			8	10.0	L
	8	11.6	J		3	11.7	J		4	7.7	Le	6	29	10.2	Ba		8	9.9	Gi
	8	11.7	Ba		3	12.3	B		5	7.9	L			230759			9	10.2	L
	9	12.0	L		4	11.6	J		6	7.4	Ba			V Cassiop.			23	9.0	L
	9	11.7	Ba		6	11.6	J		7	7.7	Le	5	5	7.0	L		28	9.0	J
	9	11.8	Gi		7	11.0	O		8	7.8	J		12	7.9	G	7	3	8.4	J
													15	7.7	G				

The rise and "long anomalous" maximum of 213843 SS Cygni was well observed with estimates well in accord. It proved to be a most interesting and unusual maximum.

Mr. C. D. Brook, Director of the V.S.S. of the B.A.A., commenting on the recent observations of this variable, in a letter to the writer cites the following points of interest.

1 "The slow rise.

2 The brightness attained notwithstanding the slow rise.

3 The length (22 days) which though not unprecedented is most unusual.

Commencement of rise	May 12-13
Maximum	" 20-21
End	June 3-4.

Altogether a creditable piece of work."

The variable 154428 R Coronae has been frequently observed by all our members. It has fluctuated narrowly around the sixth magnitude, being just visible to the naked eye. It is best observed in the field glass. In spite of its apparent constancy this variable should be frequently observed, owing to its extreme irregularity. In May and June our records show 141 observations of this variable.

Dr. Gray recently read before a meeting of the Astronomical Society of the Pacific, of which he is a member, an exceedingly interesting article entitled "A Plea for more Amateur Variable Star Observers." The Doctor is deserving of the thanks and praise of the Association for his earnest efforts to advance its interests.

An unusual and interesting observation was recently made by Mr. E.L. Forsyth, of Needles, Cal. While observing the variable *210116* RS Capricorni, he noted a bright uncharted star. Time revealed the fact that it was in motion. Mr. Forsyth communicated his observations to the Lick Observatory, and received from the Director, Professor W. W. Campbell, a cordial letter identifying the object as the asteroid Vesta.

Thanks are due to Messrs. Bancroft and Lacchini for contributions of finely executed blue prints for distribution. Enthusiasm and an earnest desire to further the advancement of the work on the part of the members continue to mark our progress.

Mr. A. Burbeck has removed from North Abington, Mass., to Buffalo, N. Y. His work therefore is interrupted for a brief period.

The "English Mechanic" cites a maximum for 142539 V Boötis May 2. Dr. Hartwig's calculated date is August 30. The variable on the former date appears to have been faint, at approximately 10.5 magnitude.

A maximum of 123307 R Virginis, calculated for May 4, was observed close to that date. The variable, however, barely attained the 8th magnitude, two magnitudes fainter than its brightest maximum.

The maximum of 142584 R Camelopard, calculated for June 3, was confirmed by the observations. 213843 SS Cygni rose again the night of July 7. The observations made by Mr. Jacobs are at about hourly intervals and very remarkable.

The record of 180531 T Herculis the third week in June is worth noting and the rapid rise of 160210 U Serpentis is extraordinary.

Space does not permit of further comment concerning the many interesting features of this report.

WM. TYLER OLCOTT
Corresponding Sec'y.

Norwich, Ct., July 10, 1913.

Observing Mercury.—I wish to report that I had a beautiful view of the planet Mercury on July 7, 1913, from 8:30 until 9 P. M. The sky was perfectly cloudless but there was so much haze in the atmosphere that the planet was not at first visible to the naked eye. After I succeeded in locating it, however, it was visible to the unaided eye, although I had to concentrate my vision for some little time on the exact spot before I could discern it. With a telescope of 2-inch aperture I followed it until it disappeared behind the western horizon exactly at 9 P.M., E.S. Time.

I remember once of observing Mercury in February when there was a fresh snow on the ground. The atmosphere was cloudless and the snow I suppose had cleared the air of dust and haze. At this time Mercury was brilliant indeed, in fact a rival of Jupiter. I saw it three nights in succession, but its altitude was not so great as it was last night. My experience in observing this planet has been that, even if its elongation is large, it is not easily visible to the naked eye in the summer time on account of too much haze.

Dr. WILL CASSELL.

Wytheville, Va. 1913, July 8.

COMET AND ASTEROID NOTES.

Elements and Ephemerides of Comet 1913 *a* Schaumasse.—In *A.N.* 4656 Messrs. Fayet and Schaumasse give elements of comet 1913 *a* depending upon observations on the dates May 6, 12 and 20, and an ephemeris extending from June 9 to July 31. The elements agree very closely with those by Wilson and Gingrich published in the June-July number of POPULAR ASTRONOMY. The comet is getting pretty faint but is still observable with a large telescope.

ELEMENTS.

$$\begin{aligned} T &= 1913\ \text{May}\ 15.1648\ \text{Paris m. t.} \\ \omega &= 53^\circ\ 2'\ 17'' \\ \Omega &= 315\ \ 5\ 25 \quad 1913.0 \\ i &= 152\ 21\ 23 \\ \log q &= 0.163514 \end{aligned}$$

CONSTANTS FOR THE EQUATOR.

$$\begin{aligned} x &= [9.975354]\ r \sin (v + 184^\circ\ 29'\ 5'') \\ y &= [9.999432]\ r \sin (v + 273\ \ 28\ \ 7\ \ ) \\ z &= [9.520507]\ r \sin (v + 355\ \ 5\ 57\ \ ) \end{aligned}$$

EPHEMERIS OF COMET 1913 *a*.

Paris Midnight 1913	α h m s	δ ° ′	log r	log Δ	$1{:}r^2\Delta^2$
July 23	12 34 24	+21 57	0.2434	0.3011	0.08
24	33 48	21 42			
25	33 15	21 27			
26	32 44	21 13			
27	32 15	20 59	0.2509	0.3245	0.07
28	31 49	20 45			
29	31 25	20 32			
30	31 2	20 19			
31	12 30 41	+20 6	0.2585	0.3462	0.06

The following elements by Professor Crawford and his assistant computers at Berkeley come to hand, in the Lick Observatory Bulletin No. 222, as we are about to go to press. They depend upon twelve observations, from May 7 to June 22, combined in three normal places. As will be seen by comparison these elements agree very closely with those given above. The ephemerides calculated from the two sets of elements are practically identical. An observation of the comet, taken at Goodsell Observatory on July 5, shows that the correction to these ephemerides is practically negligible.

ELEMENTS BY CRAWFORD

$$\begin{aligned} T &= 1913\ \text{May}\ 15.\ 14920\ \text{Gr. m. t.} \\ \omega &= 53^\circ\ 01'\ 18.5'' \\ \Omega &= 315\ \ 04\ \ 49.0 \quad 1913.0 \\ i &= 152\ \ 21\ \ 07.1 \\ q &= 1.457190 \end{aligned}$$

EPHEMERIS OF COMET 1913 *a*

Gr.M.T.		α			δ			Log Δ	Br.
		h	m	s	°	′	″		
Aug.	1.5	12	30	22.6	+19	55	21	0.3513	0.15
	3.5		29	49.9	+19	28	46		
	5.5		29	23.4	+19	05	08	0.3709	0.13
	7.5		29	02.5	+18	42	23		
	9.5		28	46.7	+18	20	28	0.3889	0.12
	11.5		28	35.6	+17	59	20		
	13.5		28	28.7	+17	38	57	0.4056	0.10
	15.5		28	25.8	+17	19	16		
	17.5		28	26.6	+17	00	14	0.4209	0.09
	19.5		28	30.7	+16	41	50		
	21.5		28	37.8	+16	24	02	0.4350	0.08
	25.5		29	00.2	+15	50	06	0.4479	0.08
	29.5		29	32.1	+15	18	15	0.4598	0.07
Sept.	2.5	12	30	12.0	+14	48	21	0.4706	0.06

Brightness May 7 = 1.00.

Observations of Schaumasse's Comet 1913 *a*.—This comet was discovered by M. Schaumasse at the Nice Observatory in France on 1913, May 6, and was observed here on three occasions with the 4-inch equatorial refractor of my observatory. Following are somewhat condensed notes of the observations which may be of some value in depicting the general aspect of the comet as revealed in a telescope of moderate power.

Comet found, 1913, May 17, $15^h\ 0^m$ C.S.T. Small, of about 10.5 stellar magnitude, (*i.e.*, fairly faint in the 4-inch), and circular. The body of the comet certainly did not exceed 1′ of arc in angular diameter. As usual in the case of faint telescopic comets, a kind of glow was visible all around the main body of the comet. Borders ill-defined. The *following* was the brightest part, but no real nucleus, nor aside from the above, any perceptible central condensation was discernible. This brightest part could not have been over 30″ in diameter, was circular and eccentrically placed with respect to the remaining part of the comet; *i.e.*, its center *followed* that of the main body of the comet. The comet was located about 1′ *n.* of a faint star, and was in a tolerably rich field. It was observed with powers of 40 and 120 diameters, respectively, and until $15^h\ 20^m$, when the observation had to be discontinued on account of the approaching dawn.

1913, May 31, $11^h\ 50^m$, comet resembled a faint blur in the telescope, but was both considerably larger and brighter than on the first observation. Center the brightest spot. The comet on this date was approximately 2′ 30″ in angular diameter at the greatest extent, and was between magnitudes 9.0 and 9.5 in brilliancy. A stellar nucleus was evident upon careful scrutiny, centrally placed and slightly below the 9.5 magnitude in luminosity. Comet excessively diffuse and difficult to define. Observed until $12^h\ 5^m$.

1913, June 3, $10^h\ 25^m$, comet of about magnitude 9.0 or slightly fainter. Nucleus of roughly the 9.0 magnitude, and placed in the *n.* part of the body of the comet, not centrally as on the former observation. That part of the comet around the nucleus was much the brightest, the rest being really only a faint glow fading off from this. Nucleus almost stellar. Comet in a fairly rich field. Observed until $10^h\ 35^m$.

The comet passed perihelion on 1913, May 16.28, according to the second set of elements computed by Kiess and Nicholson, but did not attain its maximum brilliancy until early in June, as is shown by the foregoing observations.

FREDERICK C. LEONARD.

1338 Madison Park, Chicago.
1913, July 5.

Observation of Comet 1913 *a* (Schaumasse).—It was my privilege to pass four days, from June 30 to July 4, at Lowe Observatory on Echo Mountain, Cal. Each evening was given to comet observations and search. Comet 1913 *a* was observed June 30, July 1 and July 3, with the 16-inch refractor there.

On June 30, 10:50 P. M., P. S. T., after setting roughly the 16-inch, the comet was "picked" up at first sight through the three-inch finder of 30 power. On each evening, through the larger instrument with a comet eyepiece of 150 diameters, it appeared about the same in structure. It was round, somewhat faint, and diffused toward its circumference. The comet had no discernible nucleus and a diameter of about two minutes of arc.

GILBERT LANHAM, Los Angeles, (Hollywood), California.

Elements of Asteroid QR.—At the request of Dr. Metcalf of Winchester, I have computed the approximate elements of "QR" as follows:

1913 Feb 10, Greenwich midnight

M	= 340	7	47.9
ω	= 36	5	6.74
π	= 173	40	16.89
Ω	= 137	35	10.15
i	= 22	15	20.80
e	= 0.125360		
log a	= 0.444539		
μ	= 764″.182		

x	$= r$ (9.985346)	sin (229	47	6.49	$+ u$)
y	$= r$ (9.997268)	sin (141	29	20.11	$+ u$)
z	$= r$ (9.445381)	sin (74	17	21.94	$+ u$)

F. E. SEAGRAVE.

The Mass of the Nucleus of Halley's Comet.—Professor S. Orloff, in the *Bulleiin of the St. Petersburg Academy*, 1913, No. 5, gives an investigation of the question of the mass of the nucleus of Halley's comet, based upon photometric observations. His final results indicate the mass of the nucleus in 1910 was between the fractions 0.000,000,000,000,005 and 0.000,001,6 of the mass of the earth. The smaller figure is likely to be nearer the truth than the larger one. This minimum mass, according to Dr. H. D. Curtis, in the *Publications of the Astronomical Society of the Pacific* for June, 1913, amounts to about thirty million tons, equal to less than six cubic miles of air at sea level density.

The Minor Planets of the Trojan Group.—Four of the minor planets have mean motions very close to that of Jupiter, so that their relation to that planet and the sun is practically constant, the configuration asteroid-Sun-Jupiter in each case forming an approximate equilateral triangle throughout a revolution. The following list is taken from an abstract of the doctor's thesis by Mr. Sturla Einarsson in the *Publications of the Astronomical Society of the Pacific* for June, 1913:

Name	Year of Discovery	Mean Daily Motion
(588) Achilles	1906	295″.5
(617) Patroclus	1906	300 .5
(624) Hector	1907	293 .1
(659) Nestor	1908	300 .8

The mean daily motion of Jupiter is 299″.1.

GENERAL NOTES.

The Nantucket Maria Mitchell Astronomical Fellowship of $1000 annually has been awarded a second time to Miss Margaret Harwood, A. B. (Radcliffe, '07). Her residence at the Nantucket Observatory is for six months, and the remainder of the year is spent at a larger observatory of her own choice. She has elected to continue her researches at the Harvard College Observatory during this semester. (*Science*, March 21.)

Professor Charles Lane Poor, of the Columbia University has been given leave of absence for next year.

Dr. Frank Schlesinger, director of the Allegheny Observatory, delivered a lecture on "Astronomical Photography" before the Royal Astronomical Society of Canada, at Ottawa on April 22 and at Toronto University on April 24. (*Science* May 30.)

The Rumford Premium.—At the annual meeting of the American Academy of Arts and Sciences held on May 14 last, it was voted to award the Rumford Premium to Joel Stebbins, of the University of Illinois, for his development of the selenium photometer and its application to astronomical problems. (*Science*, May 30.)

Professor S. A. Mitchell, of Columbia University, has been appointed director of the Leander McCormick Observatory at the University of Virginia, as successor to Professor Ormond Stone. During the past year Dr. Mitchell has been on sabbatical leave from Columbia and has spent his time at Yerkes Observatory in the photographic determination of stellar parallax and in spectrographic investigations of motion in the line of sight. (*Science*, July 4, 1913).

Mr. A. R. Hinks, chief assistant at the Cambridge Observatory, and university lecturer in surveying and cartography, has been appointed assistant secretary of the Royal Geographical Society. (*Science*, July 4, 1913.)

Miss Anna Estelle Glancy, Fellow in the Lick Observatory during the academic years 1908-1910, and more recently Watson Assistant in the Students Observatory, Berkeley, Cal., has been appointed assistant in the Argentine National Observatory at Cordoba. Miss Glancy's thesis, in completion of the requirements for the degree of Doctor of Philosophy in the University of California is entitled "On v. Zeipel's Theory of the Perturbations of Minor Planets of the *Hecuba* Group." An abstract is given in the June, 1913, number of the *Publications of the Astronomical Society of the Pacific.*

Mr. Sturla Einarsson, who has held the position of instructor in practical astronomy in the Berkeley Astronomical Department since 1910, received the degree of Doctor of Philosophy at the last commencement. His thesis was entitled "The Planets of the *Trojan* Group." He will continue in the position of instructor at Berkeley.

Professor A. O. Leuschner, head of the Berkeley Astronomical Department has been appointed Dean of the Graduate School, University of California. Professor Leuschner was elected a member of the National Academy of Sciences at its semi-centennial celebration, April 22-25.

Mr. H. T. Stetson of Dartmouth College has accepted a position at the Dearborn Observatory as observer and instructor in astronomy, the appointment dating from September 1.

Dr. Reynold K. Young has resigned from the position of assistant professor of astronomy and physics at the University of Kansas, to take up observational work at the Dominion Observatory at Ottawa, Canada.

Dr. Otto Klotz, astronomer at Ottawa, Canada, has received the honorary degree of doctor of science from the University of Michigan.

Mr. H. P. Newton, of Irvings Landing, B. C., Canada, formerly director of the Double and Colored Star Section of the S. P. A., resigned that position on June 2, in order to devote his time especially to planetary work. He is succeeded by Mr. A. F. Kohlman, 424½ Marshall St., Milwaukee, Wis.

Amateur Work at Dayton, Ohio.—Mr. H. D. Penney, of Dayton, Ohio, writes that he is much interested in astronomy and especially the construction of astronomical instruments. He has just completed a 2-inch refractor and has two more in process of construction, of 2½ and 4⅛-inches aperture. The 4⅛-inch will have modern mounting and equipment, including circles, driving clock, etc.

The Mathematical Works of the Late Henri Poincaré are to be published by the firm of Gauthier-Villars, under the auspices of the minister of public instruction and the Paris academy of Sciences. (*Science*, June 13, 1913.)

New Reflecting Telescope for Canada.—The Minister of the Interior of the Canadian government has authorized the purchase and installation of a reflecting telescope of not less than sixty inches aperture for the Dominion Observatory. The telescope will probably be erected at a suitable site in the Canadian Rockies. (*Science*, May 30.)

Committee to Honor Schiaparelli.—An honorary committee including the King of Italy has been appointed with the object of devising means to honor the late astronomer Giovanni Schiaparelli. Contributions are solicited by the president of the Executive Committee, M. Gallino, Savigliano (Cuneo), Italy. It is proposed to erect to the memory of Schiaparelli a monument at Savigliano, his birthplace, and to place a tablet bearing his effigy in the Brera Palace at Milan, where the great Professor expounded his doctrines. If the amount of subscriptions permits, it is proposed to found in Savigliano a Scientific Institute, which will bear the name of Schiaparelli.

The names of the subscribers will be written in an album, one copy of which will be presented to the family of the Astronomer, one to the town of Milan, and a third will be preserved in the civic museum at Savigliano.

Thirty-inch Reflector for the University of Illinois.—From the account in *The Observatory* of the April meeting of the Royal Astronomical Society (London) we learn that Professor Joel Stebbins, of the University of Illinois is to have a new 30-inch reflecting telescope with which to pursue his investigations with the selenium photometer. This will enable him to study the light variations of stars down to magnitude 4.5.

The New Solar Physics Observatory in New Zealand.—A correspondent sends in a clipping from *The Dominion*, Wellington, New Zealand, May 2, 1913, from which we take the following extracts.

"At the conclusion of a lecture given by Miss Mary Proctor last evening in the Concert Chamber an important announcement was made by the Hon. R. H. Rhodes, who presided at the lecture. The announcement was that Mr. T. Cawthron, of Nelson, had promised to donate a sum of from £10,000 to £12,000 to build, equip, and endow a solar physics observatory, to be established in Nelson province. This will mean that Miss Proctor will attain the object for which she visited New Zealand, which was to raise funds for the establishment of a solar physics observatory in Australia or in New Zealand, to link up the observatories in India and California, and so to make it possible to observe the sun continuously. At present there are about 170 degrees through which it cannot be observed at all, and the observations made therefore lack continuity, and are less valuable for the purposes of research.

"Miss Proctor has been in New Zealand with the object of raising funds for the proposed observatory, and in order to do so, and also to interest people in her project, she has delivered popular lectures in most of the principal towns in the Dominion, devoting part of the proceeds to the fund for the building of the observatory. Her mission has been entirely successful.

"The Hon. R. H. Rhodes said he esteemed it a privilege to make the announcement, which, he was sure, would be welcomed, for it seemed that Miss Proctor had achieved her object. An observatory would now be established, and it was to Mr. Thomas Cawthron, of Nelson, that they were indebted for it. Mr. Cawthron's interest in astronomy was aroused by the lectures delivered in New Zealand by Mr. R.A. Proctor some 32 years ago. Last December he read an article written by Miss Proctor referring to the need for a solar physics observatory in this part of the world, and on April 14, when Miss Proctor was in Nelson to deliver a lecture she was interviewed by Mr. Cawthron, who intimated to her that he would be prepared to assist her in her scheme in a very substantial way. Since then Miss Proctor had received a letter from Mr. Cawthron, dated April 29, at Nelson, confirming the promise in the following terms:—

> "I am also glad to find that you clearly understood my promise, which I hereby confirm—to build, equip, and endow a solar physics observatory in the vicinity of this sunny city of Nelson, at a cost of about ten to twelve thousand pounds, as estimated by yourself and Mr. Gibbs. The further development of the matter will, I imagine, now await the reply of Sir Robert Ball, of Cambridge (England) University to the letter written just after you were here to that gentleman by Mr. Gibbs, president of our Nelson Institute."

"The reading of the letter was received with cordial applause by the audience.

"Miss Proctor's lecture needs little description, if indeed it were capable of such. It was similar to others she has given in the inimitable charm and freshness with which it was delivered, for Miss Proctor can make astronomy, the oldest of all sciences, as interesting as some new and very wonderful fairy tale. Last night the mere listener without any special knowledge of his own could not but be absorbed

by Miss Proctor's references to the immensity of space, and by the sketchy story she told of the growth of our planet—Earth. She spoke of the long, almost infinite, time when the earth was in such state that no life was possible upon it, and of the time of death which would eventually come when again life could not exist upon it; she spoke of the time when the world was formless, unshapen, and lifeless, of the time when wastes of water were its only surface, of the time when the oceans had subsided and the land was covered with tropical vegetation, of the ice age when the polar caps slid down and enveloped the earth in ice, of the age following, the springtime of the earth, the age of genesis, and of the time when there would be no water and no life. This was only one short passage of Miss Proctor's lecture, and all the rest of it was equally absorbing, and both educative and entertaining."

Krieger (J) Mond-Atlas, new series, edited by R. Koenig, portrait and 31 engravings, with Atlas of 58 plates, transparent key maps opposite each and a general map of the moon (diameter of disc 16½ in.) 2 vols., roy4to, cloth. £3-5s.

Supplements and completes the first series issued in 1898 and contains all the deceased author's later work, under the editorship of R. Koenig. The text (in German) gives the needful explanations of the plates and descriptions of the single objects with dates and sketches. The atlas contains more than 800 rills and rill-like objects. The plates are on a scale which give a disc of the moon 118 to 158 inches in diameter.

Exercises in Astronomy.—Sarah Frances Whiting, Sc. D., Director of the Whitin Observatory, Wellesley College. Published by Ginn and Company. Seventy-five cents.

This little book represents the results of years of practical work by a skilful teacher, whose classes in the Whitin Observatory of Wellesley College have numbered from sixty to one hundred students. Its salient point is the independence of the exercises upon the weather. By means of globes and photographs, it is here shown how day time observations may always be made, thus placing astronomy on the same basis as the other sciences, and imitating the methods of the modern astronomers, few of whom limit themselves to nightly visual observations of the heavens. The student who plots the positions of the planets from the Nautical Almanac, as one of Miss Whiting's exercises calls for and also follows the position in the sky, not only learns how to use an ephemeris, but also cultivates the excellent habit of observing the heavens, by means of which one may obtain more lasting knowledge than by any number of lectures. In response to a circular sent out by the Committee on Teaching Astronomy, appointed by the Astronomical and Astrophysical Society of America, it was learned that, of eighty colleges and Universities, only about one third give regular observations, and only two colleges require daytime laboratory work, in addition to evening observation. It was also found that astronomy is elected by only a very small proportion of college men and women, so that there is generally, even among highly educated people, a great ignorance concerning some of the simplest facts of the science. Such exercises as the photographic study of the Pleiades, of variable stars in clusters or of various classes of stellar spectra, as presented in this little book, will give the student so many vital and interesting facts concerning the stellar universe that astronomy should become one of the most popular of all the sciences.

ANNIE J. CANNON.